TEST REPORT

Product	:	wireless headphone
Trade mark	:	Bomaker
Model/Type reference	:	Dolphin Ⅰ, Dolphin Ⅱ, Dolphin Ⅲ
Serial Number	:	N/A
Report Number	:	EED32L00383401
FCC ID	:	2AS9DDOLPH1
Date of Issue:	:	Feb. 17, 2020
Test Standards	:	47 CFR Part 15 Subpart C
Test result	:	PASS

Prepared for:

GuangDong Substanbo Technology Co., Ltd.
8F, Building D, Bantian International Center,
Longgang District, Shenzhen, China

Prepared by:

Centre Testing International Group Co., Ltd.
Hongwei Industrial Zone, Bao'an 70 District,
Shenzhen, Guangdong, China
TEL: +86-755-3368 3668
FAX: +86-755-3368 3385

Compiled by: Smile Zhong — Smile Zhong

Reviewed by: Ware Xin — Ware Xin

Approved by: Sam Chuang — Sam Chuang

Date: Feb. 17, 2020

Check No.:3096393594

CENTRE TESTING INTERNATIONAL GROUP CO.,LTD. CTI Report Seal

2 Version

Version No.	Date	Description
00	Feb. 17, 2020	Original

3 Test Summary

Test Item	Test Requirement	Test method	Result
Antenna Requirement	47 CFR Part 15, Subpart C Section 15.203/15.247 (c)	ANSI C63.10-2013	PASS
AC Power Line Conducted Emission	47 CFR Part 15, Subpart C Section 15.207	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15, Subpart C Section 15.247 (b)(1)	ANSI C63.10-2013	PASS
20dB Occupied Bandwidth	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Carrier Frequencies Separation	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Hopping Channel Number	47 CFR Part 15, Subpart C Section 15.247 (b)	ANSI C63.10-2013	PASS
Dwell Time	47 CFR Part 15, Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013	PASS
Pseudorandom Frequency Hopping Sequence	47 CFR Part 15, Subpart C Section 15.247(b)(4)&TCB Exclusion List (7 July 2002)	ANSI C63.10-2013	PASS
RF Conducted Spurious Emissions	47 CFR Part 15, Subpart C Section 15.247(d)	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15, Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS

Remark:
Test according to ANSI C63.4-2014 & ANSI C63.10-2013.
The tested samples and the sample information are provided by the client.
Model No.: Dolphin Ⅰ, Dolphin Ⅱ, Dolphin Ⅲ
Only the model Dolphin Ⅰ was tested, since the electrical circuit design, layout, components used and internal wiring were identical for the above models, with difference model name.

4 Content

1 COVER PAGE 1

2 VERSION 2

3 TEST SUMMARY 3

4 CONTENT 4

5 TEST REQUIREMENT 5

5.1 TEST SETUP 5
5.1.1 For Conducted test setup 5
5.1.2 For Radiated Emissions test setup 5
5.1.3 For Conducted Emissions test setup 6
5.2 TEST ENVIRONMENT 6
5.3 TEST CONDITION 6

6 GENERAL INFORMATION 7

6.1 CLIENT INFORMATION 7
6.2 GENERAL DESCRIPTION OF EUT 7
6.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD 7
6.4 DESCRIPTION OF SUPPORT UNITS 8
6.5 TEST LOCATION 8
6.6 DEVIATION FROM STANDARDS 8
6.7 ABNORMALITIES FROM STANDARD CONDITIONS 9
6.8 OTHER INFORMATION REQUESTED BY THE CUSTOMER 9
6.9 MEASUREMENT UNCERTAINTY(95% CONFIDENCE LEVELS, K=2) 9

7 EQUIPMENT LIST 10

8 RADIO TECHNICAL REQUIREMENTS SPECIFICATION 13

EUT DUTY CYCLE 14
Appendix A): 20dB Occupied Bandwidth 15
Appendix B): Carrier Frequency Separation 23
Appendix C): Dwell Time 28
Appendix D): Hopping Channel Number 33
Appendix E): Conducted Peak Output Power 36
Appendix F): Band-edge for RF Conducted Emissions 41
Appendix G): RF Conducted Spurious Emissions 47
Appendix H) Pseudorandom Frequency Hopping Sequence 58
Appendix I) Antenna Requirement 59
Appendix J) AC Power Line Conducted Emission 60
Appendix K) Restricted bands around fundamental frequency (Radiated) 63
Appendix L) Radiated Spurious Emissions 80

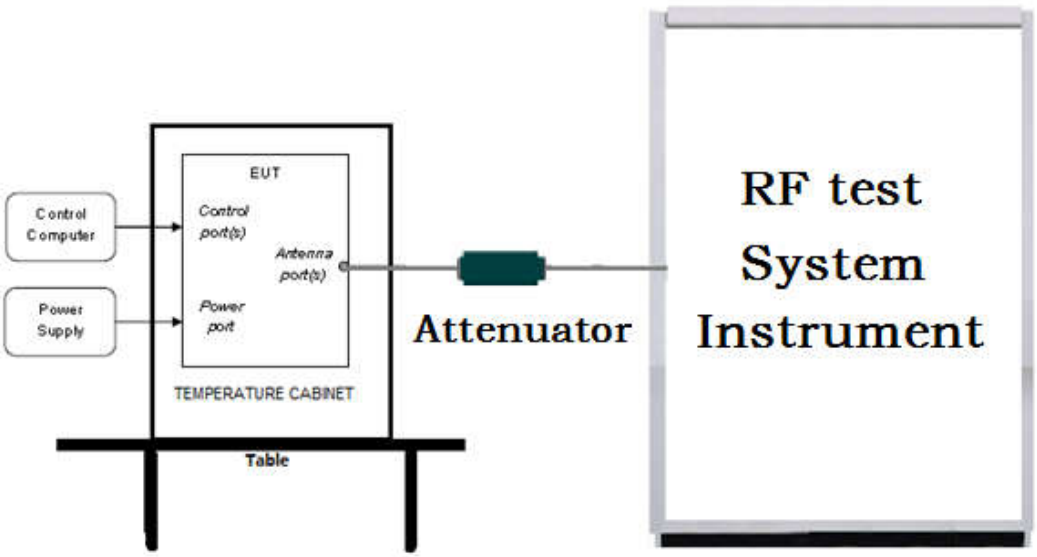
PHOTOGRAPHS OF TEST SETUP 85

PHOTOGRAPHS OF EUT CONSTRUCTIONAL DETAILS 87

5 Test Requirement

5.1 Test setup

5.1.1 For Conducted test setup



5.1.2 For Radiated Emissions test setup

Radiated Emissions setup:

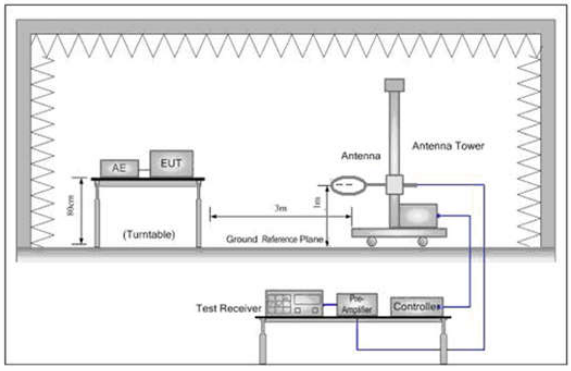


Figure 1. Below 30MHz

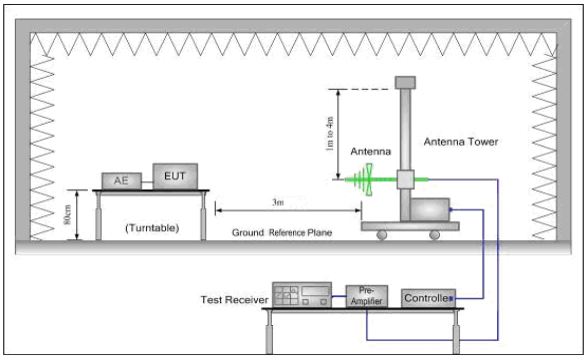


Figure 2. 30MHz to 1GHz

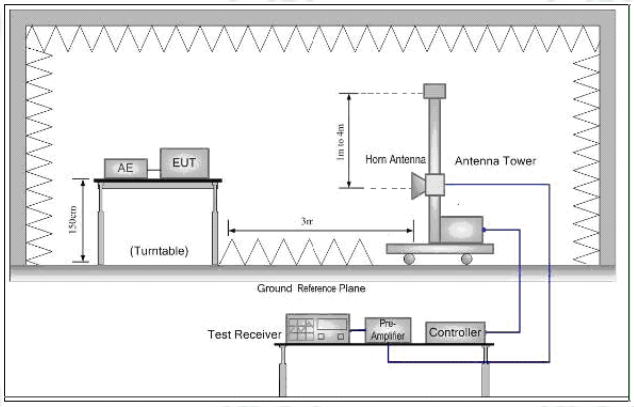
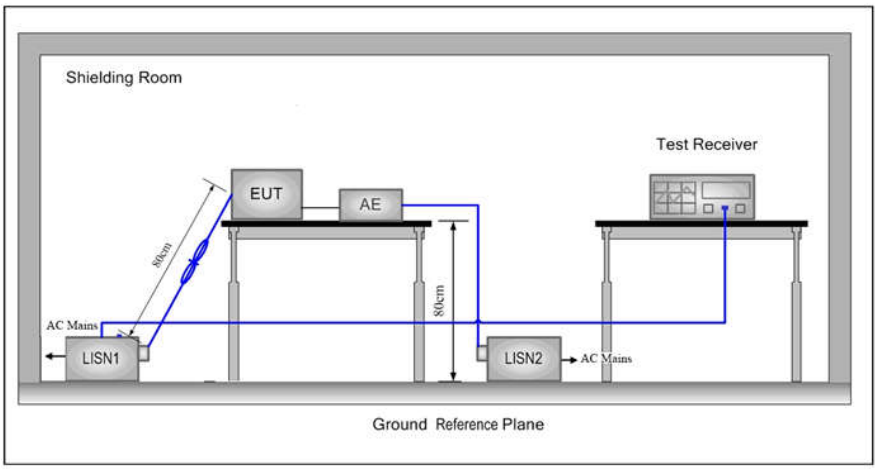


Figure 3. Above 1GHz

5.1.3 For Conducted Emissions test setup

Conducted Emissions setup



5.2 Test Environment

Operating Environment:	
Temperature:	24.0 °C
Humidity:	54 % RH
Atmospheric Pressure:	1010mbar

5.3 Test Condition

Test Mode	Tx/Rx	RF Channel		
		Low(L)	Middle(M)	High(H)
GFSK/π/4DQPSK/ 8DPSK(DH1,DH3,DH5)	2402MHz ~2480 MHz	Channel 1	Channel 40	Channel79
		2402MHz	2441MHz	2480MHz

6 General Information

6.1 Client Information

Applicant:	GuangDong Substanbo Technology Co., Ltd.
Address of Applicant:	8F, Building D, Bantian International Center, Longgang District, Shenzhen, China
Manufacturer:	GuangDong Substanbo Technology Co., Ltd.
Address of Manufacturer:	8F, Building D, Bantian International Center, Longgang District, Shenzhen, China
Factory:	Shenzhen Vtsonic Co., LTD.
Address of Factory:	No.35, 2nd Industry Zone, Tangxiayong, Songgang Street, Bao'an District, Shenzhen, Guangdong Province, P.R.China.

6.2 General Description of EUT

Product Name:	wireless headphone	
Model No.(EUT):	Dolphin Ⅰ, Dolphin Ⅱ, Dolphin Ⅲ	
Test Mode No.:	Dolphin Ⅰ	
Tark mark:	Bomaker	
EUT Supports Radios application	BT 4.2 Singlel mode, 2402MHz to 2480MHz	
Power Supply:	Battery	DC 3.7V/300mAh,Charge DC 5V
Sample Received Date:	Dec. 19, 2019	
Sample tested Date:	Dec. 19, 2019 to Jan. 02, 2020	

6.3 Product Specification subjective to this standard

Operation Frequency:	2402MHz~2480MHz
Bluetooth Version:	4.2 (BT 2.1+EDR)
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, π/4DQPSK, 8DPSK
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Test Power Grade:	DH5:50; 2DH5:50; 3DH5:50
Test Software of EUT:	Bluetest3
Antenna Type:	FPC Antenna
Antenna Gain:	1dBi
Test Voltage:	DC 3.7V

Operation Frequency each of channel							
Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	2402MHz	21	2422MHz	41	2442MHz	61	2462MHz
2	2403MHz	22	2423MHz	42	2443MHz	62	2463MHz
3	2404MHz	23	2424MHz	43	2444MHz	63	2464MHz
4	2405MHz	24	2425MHz	44	2445MHz	64	2465MHz
5	2406MHz	25	2426MHz	45	2446MHz	65	2466MHz
6	2407MHz	26	2427MHz	46	2447MHz	66	2467MHz
7	2408MHz	27	2428MHz	47	2448MHz	67	2468MHz
8	2409MHz	28	2429MHz	48	2449MHz	68	2469MHz
9	2410MHz	29	2430MHz	49	2450MHz	69	2470MHz
10	2411MHz	30	2431MHz	50	2451MHz	70	2471MHz
11	2412MHz	31	2432MHz	51	2452MHz	71	2472MHz
12	2413MHz	32	2433MHz	52	2453MHz	72	2473MHz
13	2414MHz	33	2434MHz	53	2454MHz	73	2474MHz
14	2415MHz	34	2435MHz	54	2455MHz	74	2475MHz
15	2416MHz	35	2436MHz	55	2456MHz	75	2476MHz
16	2417MHz	36	2437MHz	56	2457MHz	76	2477MHz
17	2418MHz	37	2438MHz	57	2458MHz	77	2478MHz
18	2419MHz	38	2439MHz	58	2459MHz	78	2479MHz
19	2420MHz	39	2440MHz	59	2460MHz	79	2480MHz
20	2421MHz	40	2441MHz	60	2461MHz		

6.4 Description of Support Units

Associated equipment name		Manufacture	model	S/N serial number	Supplied by	Certification
AE1	Notebook	HP	HP 430 G3	5CD6082JLC	CTI	CTI

6.5 Test Location

All tests were performed at:

Centre Testing International Group Co., Ltd.
Building C, Hongwei Industrial Park Block 70, Bao'an District, Shenzhen, China
Telephone: +86 (0) 755 33683668 Fax:+86 (0) 755 33683385
No tests were sub-contracted.
FCC Designation No.: CN1164

6.6 Deviation from Standards

None.

6.7 Abnormalities from Standard Conditions

None.

6.8 Other Information Requested by the Customer

None.

6.9 Measurement Uncertainty(95% confidence levels, k=2)

No.	Item	Measurement Uncertainty
1	Radio Frequency	7.9×10^{-8}
2	RF power, conducted	0.46dB (30MHz-1GHz)
		0.55dB (1GHz-18GHz)
3	Radiated Spurious emission test	4.3dB (30MHz-1GHz)
		4.5dB (1GHz-12.75GHz)
4	Conduction emission	3.5dB (9kHz to 150kHz)
		3.1dB (150kHz to 30MHz)
5	Temperature test	0.64°C
6	Humidity test	3.8%
7	DC power voltages	0.026%

7 Equipment List

RF test system					
Equipment	**Manufacturer**	**Mode No.**	**Serial Number**	**Cal. Date (mm-dd-yyyy)**	**Cal. Due date (mm-dd-yyyy)**
Spectrum Analyzer	Keysight	N9010A	MY54510339	03-01-2019	02-29-2020
Signal Generator	Keysight	N5182B	MY53051549	03-01-2019	02-29-2020
Temperature/ Humidity Indicator	biaozhi	HM10	1804186	07-26-2019	07-25-2020
High-pass filter	Sinoscite	FL3CX03WG18N M12-0398-002	---	01-09-2019	01-08-2020
High-pass filter	MICRO-TRONICS	SPA-F-63029-4	---	01-09-2019	01-08-2020
DC Power	Keysight	E3642A	MY56376072	03-01-2019	02-29-2020
PC-1	Lenovo	R4960d	---	03-01-2019	02-29-2020
BT&WI-FI Automatic control	R&S	OSP120	101374	03-01-2019	02-29-2020
RF control unit	JS Tonscend	JS0806-2	158060006	03-01-2019	02-29-2020
BT&WI-FI Automatic test software	JS Tonscend	JS1120-3	---	03-01-2019	02-29-2020

Conducted disturbance Test					
Equipment	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm-dd-yyyy)**	**Cal. Due date (mm-dd-yyyy)**
Receiver	R&S	ESCI	100435	05-20-2019	05-19-2020
Temperature/ Humidity Indicator	Defu	TH128	/	06-14-2019	06-13-2020
LISN	R&S	ENV216	100098	05-08-2019	05-07-2020
Barometer	changchun	DYM3	1188	06-20-2019	06-19-2020

3M Semi/full-anechoic Chamber					
Equipment	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm-dd-yyyy)**	**Cal. Due date (mm-dd-yyyy)**
3M Chamber & Accessory Equipment	TDK	SAC-3	---	05-24-2019	05-23-2022
TRILOG Broadband Antenna	Schwarzbeck	VULB9163	9163-618	07-26-2019	07-25-2020
Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-076	04-25-2018	04-24-2021
Receiver	R&S	ESCI7	100938-003	10-21-2019	10-20-2020
Multi device Controller	maturo	NCD/070/107 11112	---	01-09-2019	01-08-2020
Temperature/ Humidity Indicator	Shanghai qixiang	HM10	1804298	07-26-2019	07-25-2020
Cable line	Fulai(7M)	SF106	5219/6A	01-09-2019	01-08-2020
Cable line	Fulai(6M)	SF106	5220/6A	01-09-2019	01-08-2020
Cable line	Fulai(3M)	SF106	5216/6A	01-09-2019	01-08-2020
Cable line	Fulai(3M)	SF106	5217/6A	01-09-2019	01-08-2020

3M full-anechoic Chamber					
Equipment	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date (mm-dd-yyyy)**	**Cal. Due date (mm-dd-yyyy)**
RSE Automatic test software	JS Tonscend	JS36-RSE	10166	06-19-2019	06-18-2020
Receiver	Keysight	N9038A	MY57290136	03-27-2019	03-26-2020
Spectrum Analyzer	Keysight	N9020B	MY57111112	03-27-2019	03-26-2020
Spectrum Analyzer	Keysight	N9030B	MY57140871	03-27-2019	03-26-2020
TRILOG Broadband Antenna	Schwarzbeck	VULB 9163	9163-1148	04-25-2018	04-24-2021
Horn Antenna	Schwarzbeck	BBHA 9170	9170-832	04-25-2018	04-24-2021
Horn Antenna	ETS-LINDGREN	3117	00057407	07-10-2018	07-09-2021
Preamplifier	EMCI	EMC184055SE	980596	05-22-2019	5-21-2020
Preamplifier	EMCI	EMC001330	980563	05-08-2019	05-07-2020
Preamplifier	JS Tonscend	980380	EMC051845 SE	01-16-2019	01-15-2020
Temperature/ Humidity Indicator	biaozhi	GM1360	EE1186631	04-30-2019	04-29-2020
Fully Anechoic Chamber	TDK	FAC-3	---	01-17-2018	01-16-2021
Filter bank	JS Tonscend	JS0806-F	188060094	04-10-2018	04-09-2021
Cable line	Times	SFT205-NMSM-2.50M	394812-0001	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMSM-2.50M	394812-0002	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMSM-2.50M	394812-0003	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMSM-2.50M	393495-0001	01-09-2019	01-08-2020
Cable line	Times	EMC104-NMNM-1000	SN160710	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMSM-3.00M	394813-0001	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMNM-1.50M	381964-0001	01-09-2019	01-08-2020
Cable line	Times	SFT205-NMSM-7.00M	394815-0001	01-09-2019	01-08-2020
Cable line	Times	HF160-KMKM-3.00M	393493-0001	01-09-2019	01-08-2020

8 Radio Technical Requirements Specification

Reference documents for testing:

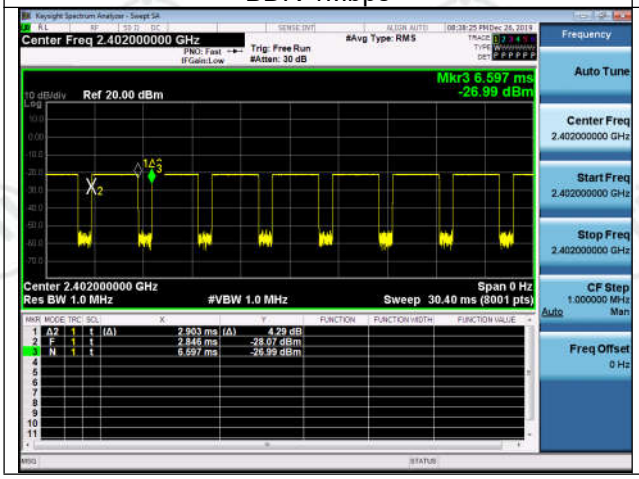
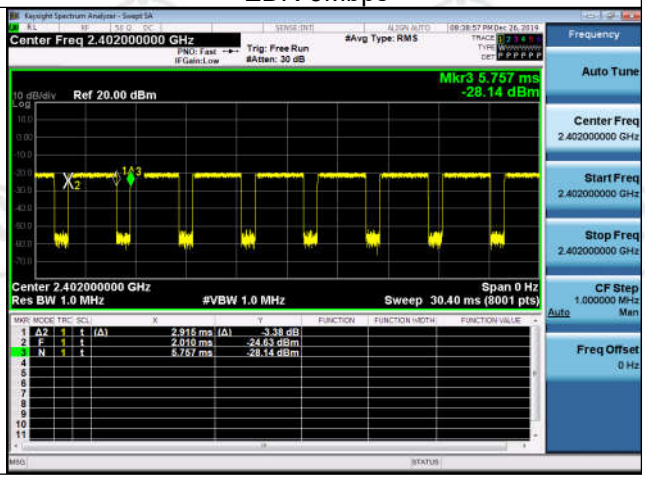
No.	Identity	Document Title
1	FCC Part 15C	Subpart C-Intentional Radiators
2	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices

Test Results List:

Test requirement	Test method	Test item	Verdict	Note
Part15C Section 15.247 (a)(1)	ANSI 63.10	20dB Occupied Bandwidth	PASS	Appendix A)
Part15C Section 15.247 (a)(1)	ANSI 63.10	Carrier Frequencies Separation	PASS	Appendix B)
Part15C Section 15.247 (a)(1)	ANSI 63.10	Dwell Time	PASS	Appendix C)
Part15C Section 15.247 (b)	ANSI 63.10	Hopping Channel Number	PASS	Appendix D)
Part15C Section 15.247 (b)(1)	ANSI 63.10	Conducted Peak Output Power	PASS	Appendix E)
Part15C Section 15.247(d)	ANSI 63.10	Band-edge for RF Conducted Emissions	PASS	Appendix F)
Part15C Section 15.247(d)	ANSI 63.10	RF Conducted Spurious Emissions	PASS	Appendix G)
Part15C Section 15.247 (a)(1)	ANSI 63.10	Pseudorandom Frequency Hopping Sequence	PASS	Appendix H)
Part15C Section 15.203/15.247 (c)	ANSI 63.10	Antenna Requirement	PASS	Appendix I)
Part15C Section 15.207	ANSI 63.10	AC Power Line Conducted Emission	PASS	Appendix J)
Part15C Section 15.205/15.209	ANSI 63.10	Restricted bands around fundamental frequency (Radiated) Emission)	PASS	Appendix K)
Part15C Section 15.205/15.209	ANSI 63.10	Radiated Spurious Emissions	PASS	Appendix L)

EUT DUTY CYCLE

Duty Cycle			
Configuration	TX ON(ms)	TX ALL(ms)	Duty Cycle(%)
BDR-1Mbps	2.903	3.751	77.4%
EDR-3Mbps	2.915	3.747	77.80%

BDR-1Mbps	EDR-3Mbps
	

Appendix A): 20dB Occupied Bandwidth

Test Limit

According to §15.247(a) (1),

20 dB Bandwidth : For reporting purposes only.

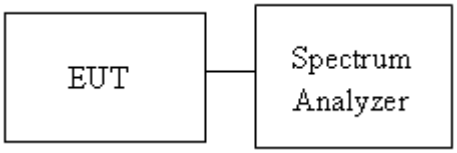
Occupied Bandwidth(99%) : For reporting purposes only.

Test Procedure

Test method Refer as Section 8.1 and ANSI C63.10: 2013 clause 7.8.7,

1. The EUT RF output connected to the spectrum analyzer by RF cable.
2. Setting maximum power transmit of EUT
3. SA set RBW =100kHz, VBW = 300kHz and Detector = Peak, to measurement 20dB Bandwidth.
4. SA set RBW = 1% ~ 5% OBW, VBW = three times the RBW and Detector = Peak, to measurement 99% Bandwidth.
5. Measure and record the result of 20 dB Bandwidth and 99% Bandwidth. in the test report.

Test Setup



Test Result

99% Bandwidth

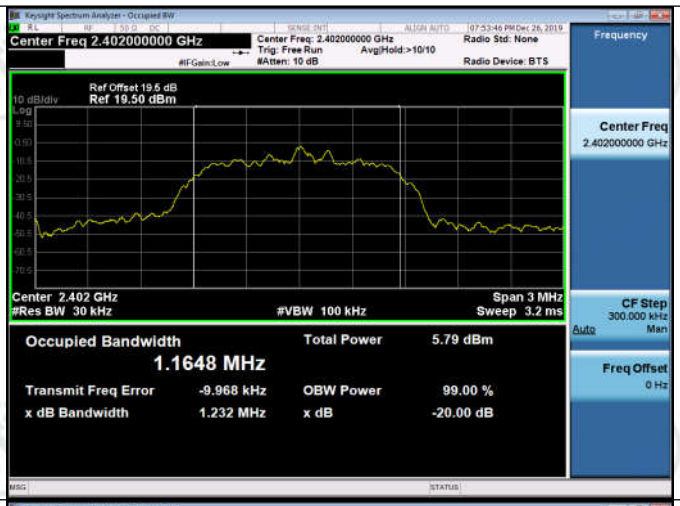
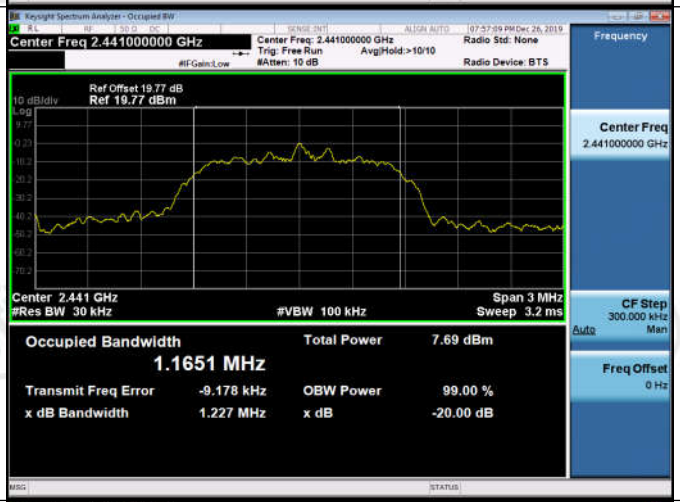
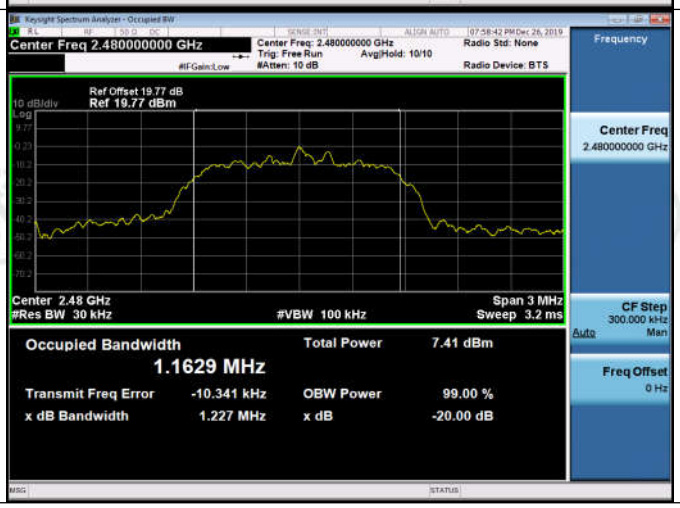
Mode	Channel.	99% OBW [MHz]	Verdict
GFSK	LCH	0.87078	PASS
GFSK	MCH	0.85872	PASS
GFSK	HCH	0.85626	PASS
π /4DQPSK	LCH	1.1648	PASS
π /4DQPSK	MCH	1.1651	PASS
π /4DQPSK	HCH	1.1629	PASS
8DPSK	LCH	1.1580	PASS
8DPSK	MCH	1.1584	PASS
8DPSK	HCH	1.1586	PASS

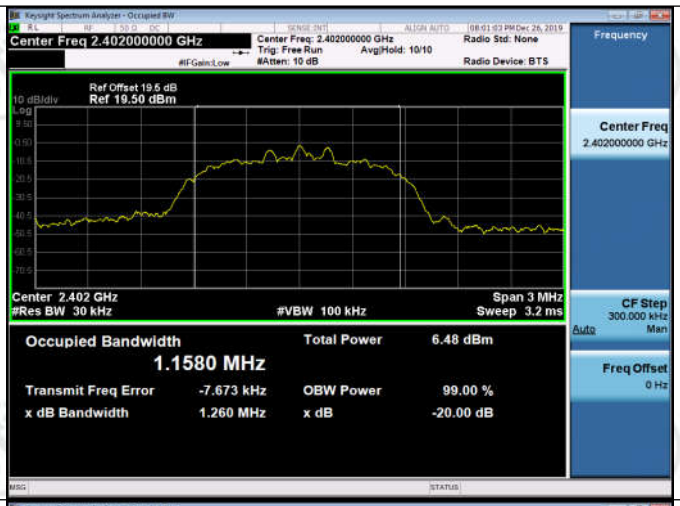
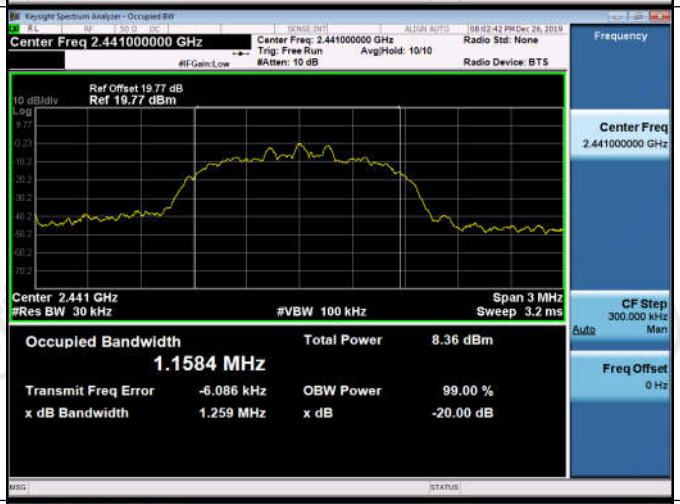
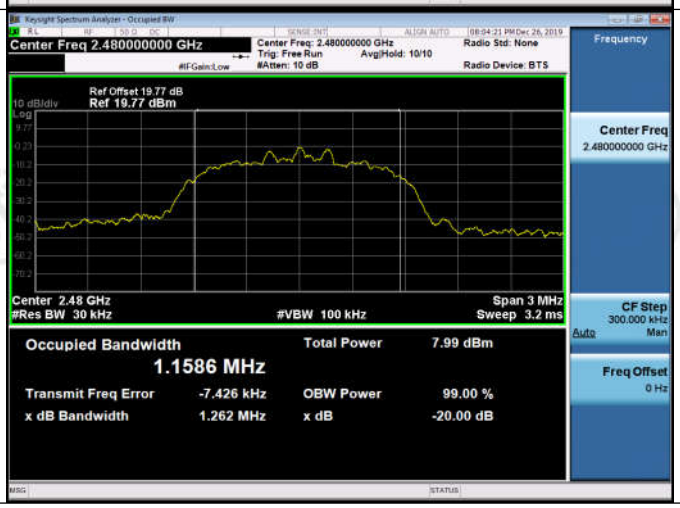
20 dB Bandwidth

Mode	Channel.	20dB Bandwidth [MHz]	Verdict
GFSK	LCH	1.112	PASS
GFSK	MCH	1.109	PASS
GFSK	HCH	1.113	PASS
π /4DQPSK	LCH	1.366	PASS
π /4DQPSK	MCH	1.363	PASS
π /4DQPSK	HCH	1.367	PASS
8DPSK	LCH	1.366	PASS
8DPSK	MCH	1.369	PASS
8DPSK	HCH	1.366	PASS

Test Graph

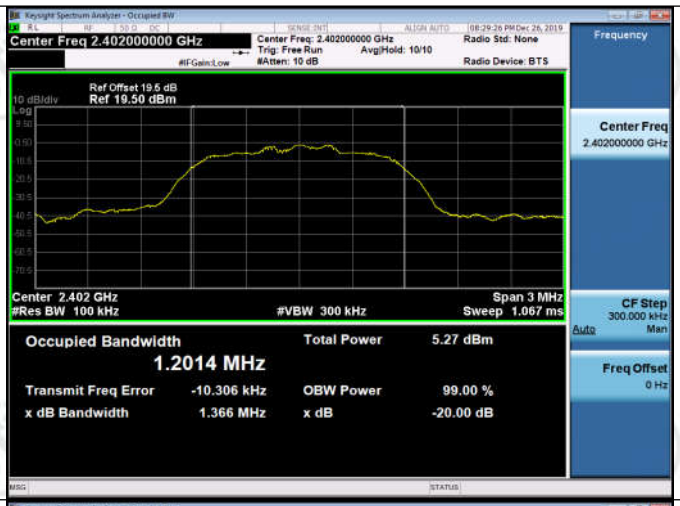
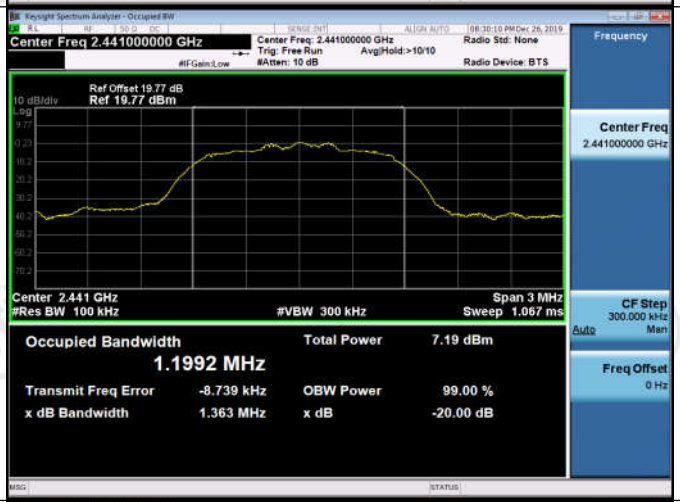
	Graphs	
GFSK/LCH		
GFSK/MCH		
GFSK/HCH		

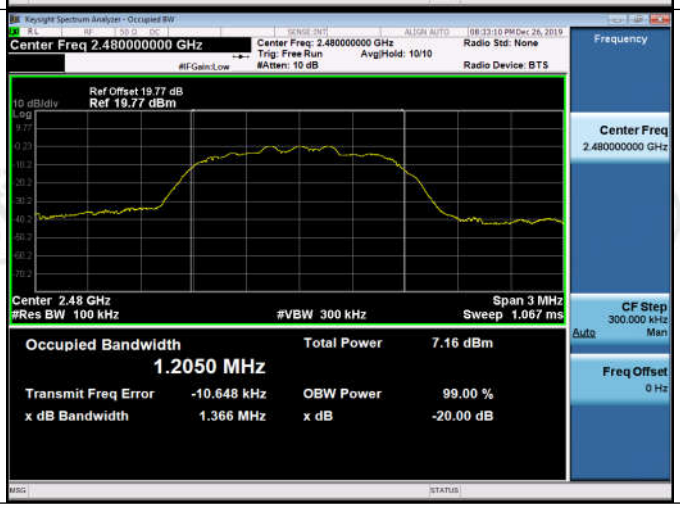
π/4DQPSK/LCH			
π/4DQPSK/MCH			
π/4DQPSK/HCH			

8DPSK/LCH			
8DPSK/MCH			
8DPSK/HCH			

20dB down:

	Graphs	
GFSK/LCH		
GFSK/MCH		
GFSK/HCH		

π/4DQPSK/LCH			
π/4DQPSK/MCH			
π/4DQPSK/HCH			

8DPSK/LCH			
8DPSK/MCH			
8DPSK/HCH			

Appendix B): Carrier Frequency Separation

Test Limit

According to §15.247(a)(1),

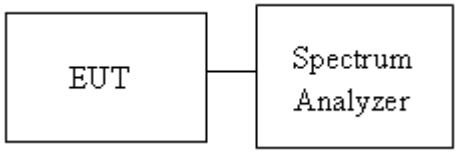
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Limit	> two-thirds of the 20 dB bandwidth

Test Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. EUT RF output port connected to the SA by RF cable.
3. Set the spectrum analyzer as RBW = 30kHz, VBW = 100kHz, Sweep = auto.
   Max hold, mark 3 peaks of hopping channel and record the 3 peaks frequency

Test Setup

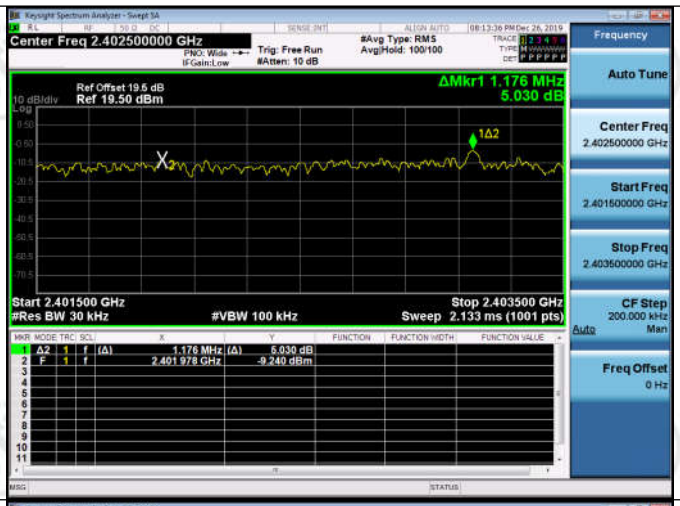
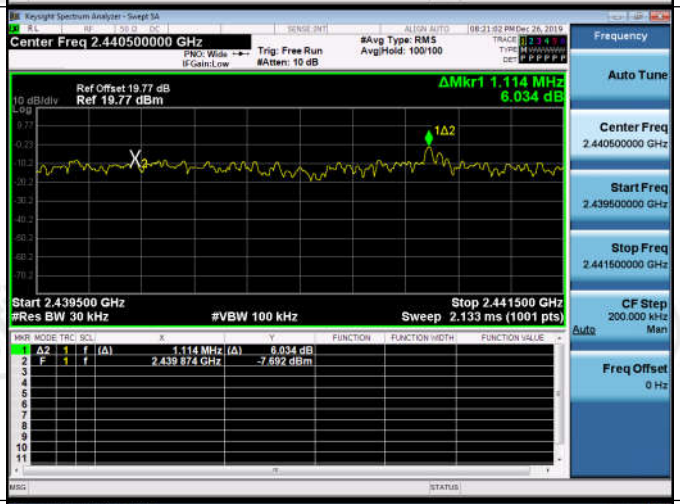


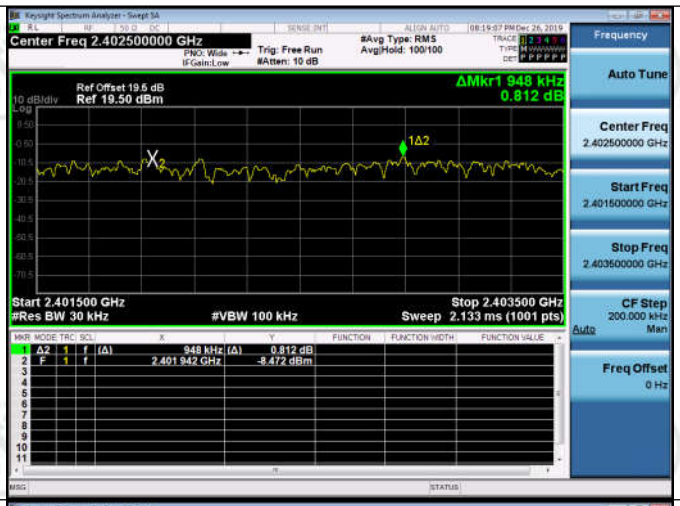
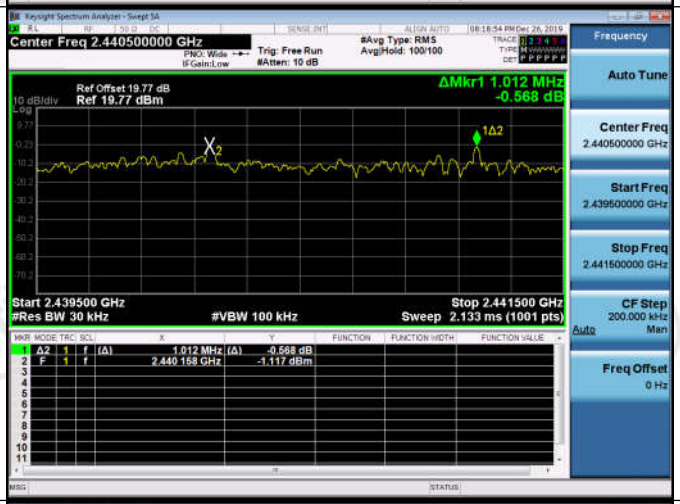
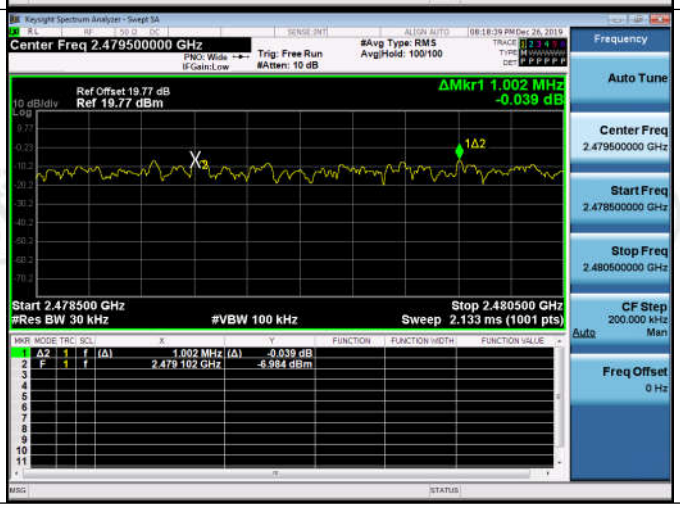
Result Table

Mode	Channel.	Carrier Frequency Separation [MHz]	Verdict
GFSK	LCH	0.960	PASS
GFSK	MCH	1.016	PASS
GFSK	HCH	0.916	PASS
π/4DQPSK	LCH	1.176	PASS
π/4DQPSK	MCH	1.114	PASS
π/4DQPSK	HCH	0.996	PASS
8DPSK	LCH	0.948	PASS
8DPSK	MCH	1.012	PASS
8DPSK	HCH	1.002	PASS

Test Graph

	Graphs	
GFSK/LCH		
GFSK/MCH		
GFSK/HCH		

π/4DQPSK/LCH			
π/4DQPSK/MCH			
π/4DQPSK/HCH			

8DPSK/LCH			
8DPSK/MCH			
8DPSK/HCH			

Appendix C): Dwell Time

Test Limit

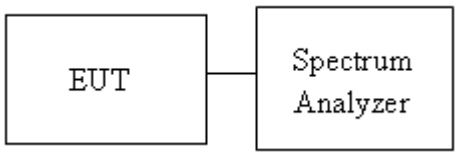
According to §15.247(a)(1)(iii),

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Procedure

1. EUT RF output port connected to the SA by RF cable.
2. Set center frequency of spectrum analyzer = operating frequency.
3. *Set the spectrum analyzer as RBW=1MHz, VBW=3MHz, Sweep = auto*

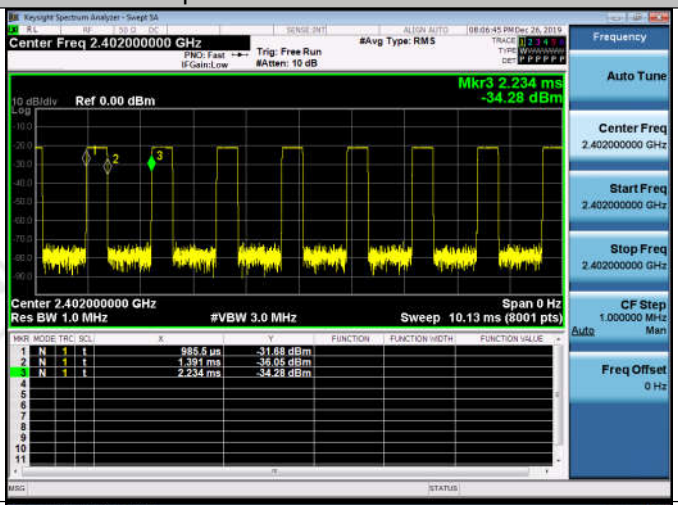
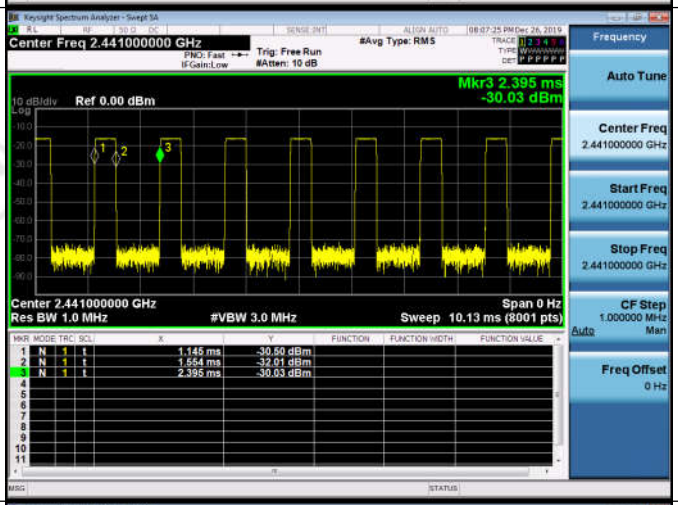
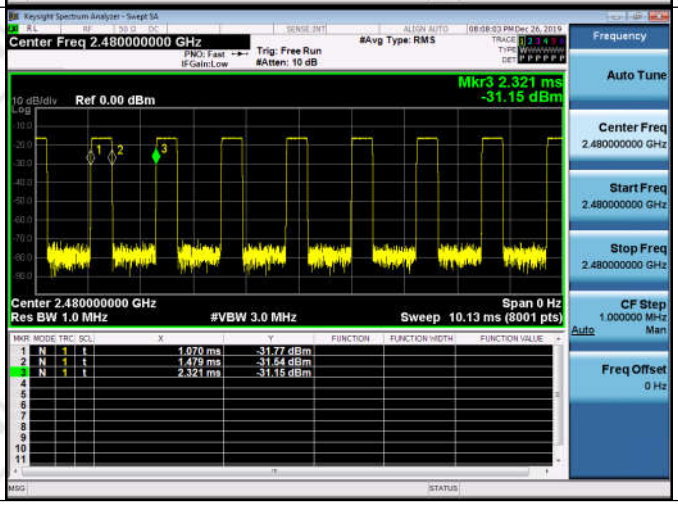
Test Setup

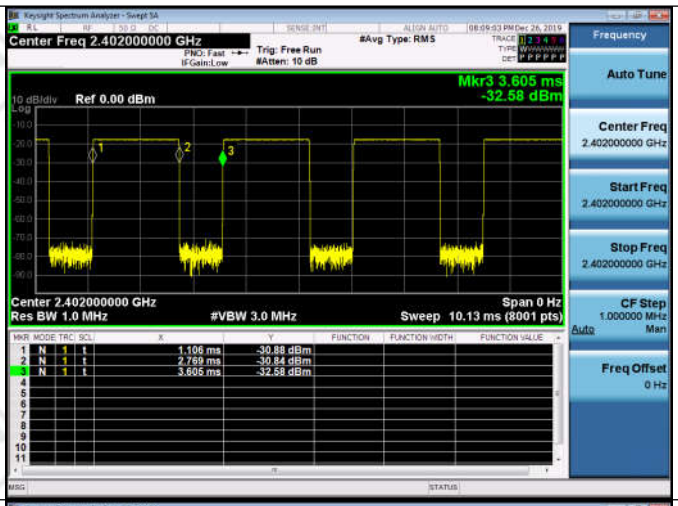
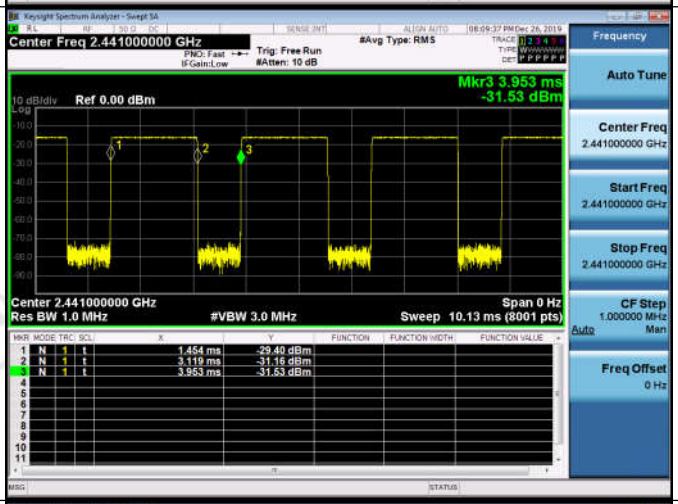
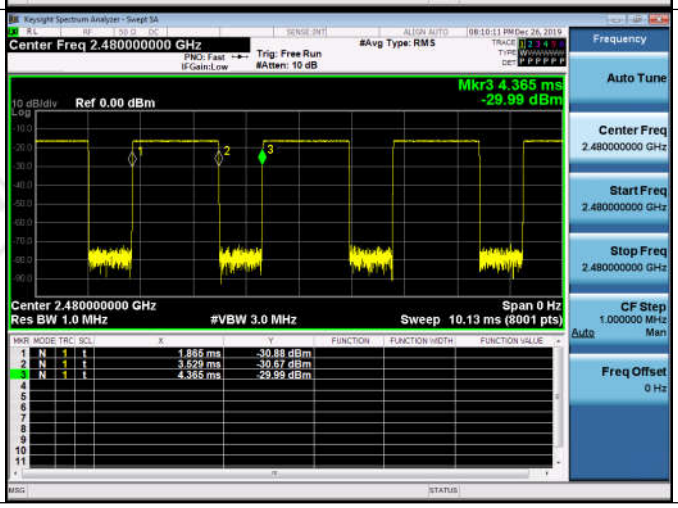


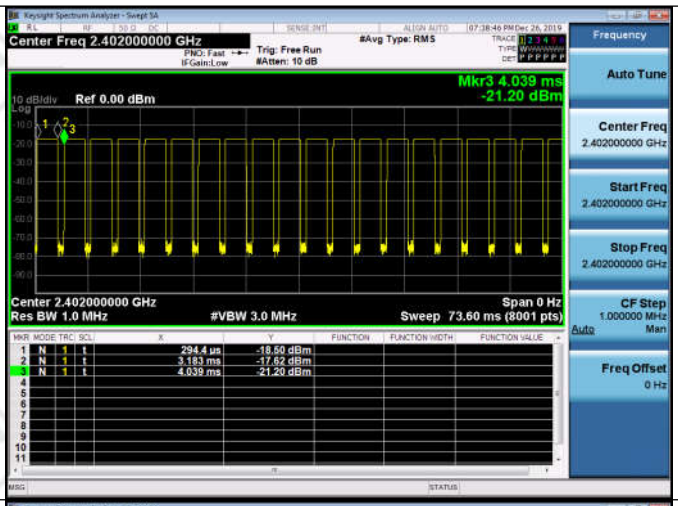
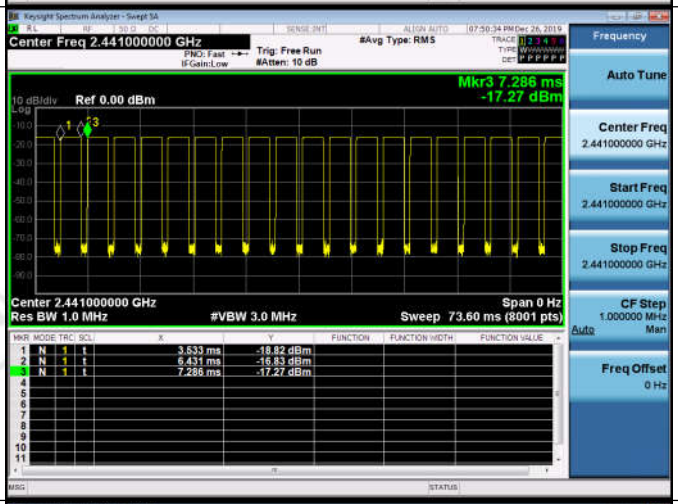
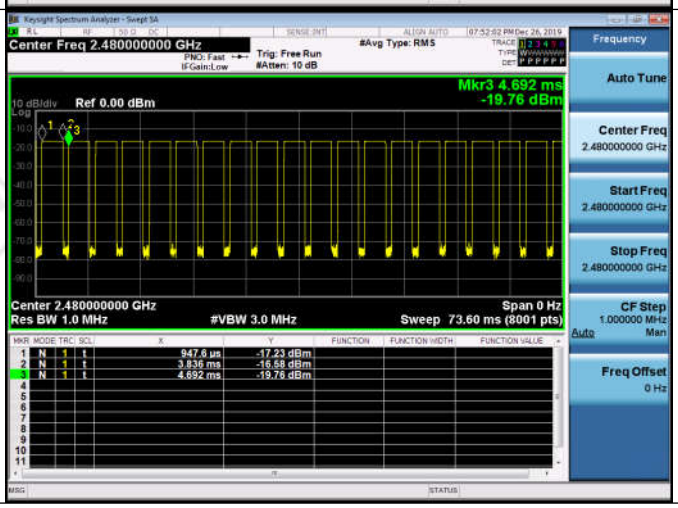
Result Table

Mode	Packet	Channel	Burst Width [ms/hop/ch]	Total Hops[hop*ch]	Dwell Time[s]	Duty Cycle [%]	Verdict
GFSK	DH1	LCH	0.40533	320	0.130	0.32	PASS
GFSK	DH1	MCH	0.40913	320	0.131	0.33	PASS
GFSK	DH1	HCH	0.40914	320	0.131	0.33	PASS
GFSK	DH3	LCH	1.6631	160	0.266	0.67	PASS
GFSK	DH3	MCH	1.6644	160	0.266	0.67	PASS
GFSK	DH3	HCH	1.6644	160	0.266	0.67	PASS
GFSK	DH5	LCH	2.8888	106.7	0.308	0.77	PASS
GFSK	DH5	MCH	2.8980	106.7	0.309	0.77	PASS
GFSK	DH5	HCH	2.8888	106.7	0.308	0.77	PASS

Test Graph

Graphs			
GFSK_DH1/LCH			
GFSK_DH1/MCH			
GFSK_DH1/HCH			

GFSK_DH3/LCH			
GFSK_DH3/MCH			
GFSK_DH3/HCH			

GFSK_DH5/LCH			
GFSK_DH5/MCH			
GFSK_DH5/HCH			

Appendix D): Hopping Channel Number

Test Limit

According to §15.247(a)(1)(iii)

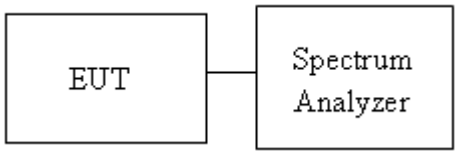
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

Test Procedure

Test method Refer as ANSI C63.10: 2013 clause 7.8.3

1. Place the EUT on the table and set it in transmitting mode.
2. EUT RF output port connected to the SA by RF cable.
3. Set spectrum analyzer Start Freq. = 2400 MHz, Stop Freq. = 2483.5 MHz, RBW =100KHz, VBW = 300KHz.
4. Max hold, view and count how many channel in the band.

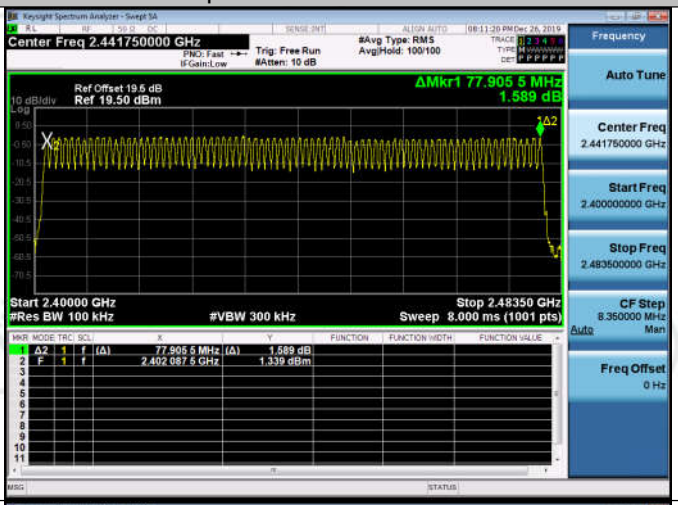
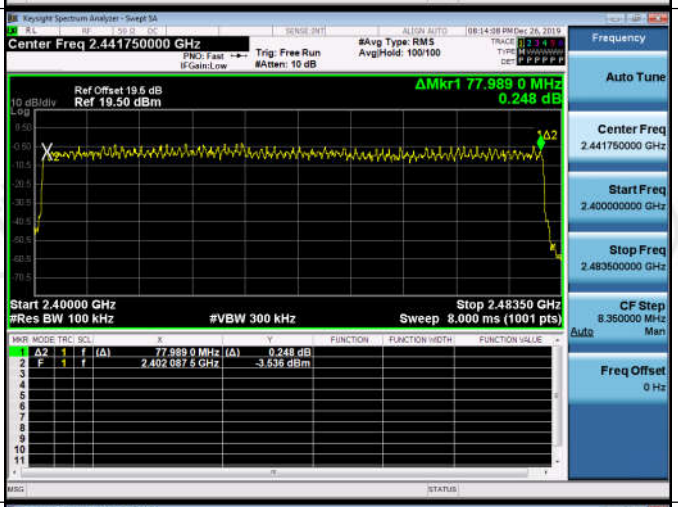
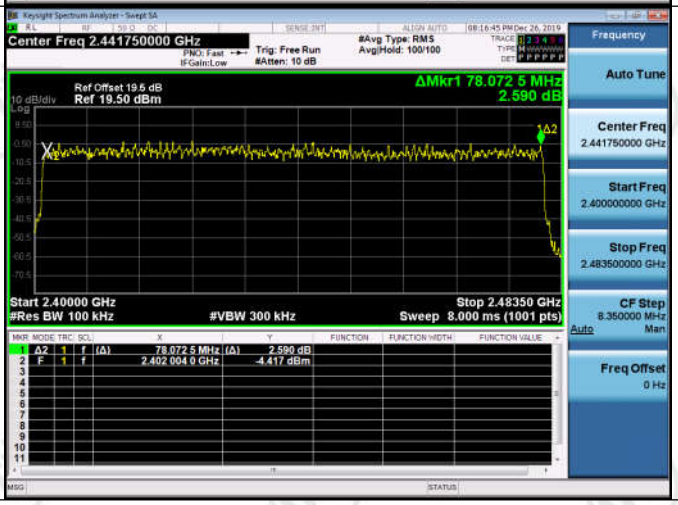
Test Setup



Result Table

Mode	Channel.	Number of Hopping Channel	Verdict
GFSK	Hop	79	PASS
π/4DQPSK	Hop	79	PASS
8DPSK	Hop	79	PASS

Test Graph

	Graphs
GFSK/Hop	
π/4DQPSK/Hop	
8DPSK/Hop	

Appendix E): Conducted Peak Output Power

Test Limit

According to §15.247(b)(1).

Peak output power：

FCC

Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

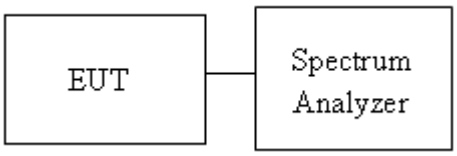
Limit	☒ Antenna not exceed 6 dBi：21dBm ☐ Antenna with DG greater than 6 dBi：21dBm [Limit = 30 – (DG – 6)]

Average output power：For reporting purposes only.

Test Procedure

1. The EUT RF output connected to the power meter by RF cable.
2. Setting maximum power transmit of EUT.
3. The path loss was compensated to the results for each measurement.
4. Measure and record the result of Peak output power and Average output power. in the test report.

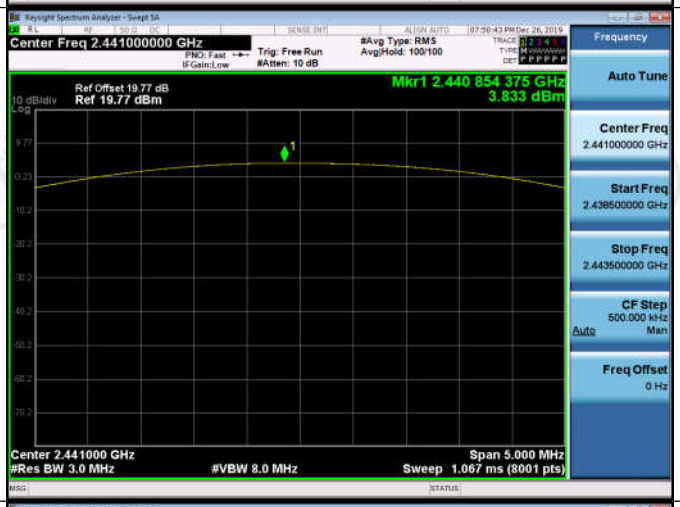
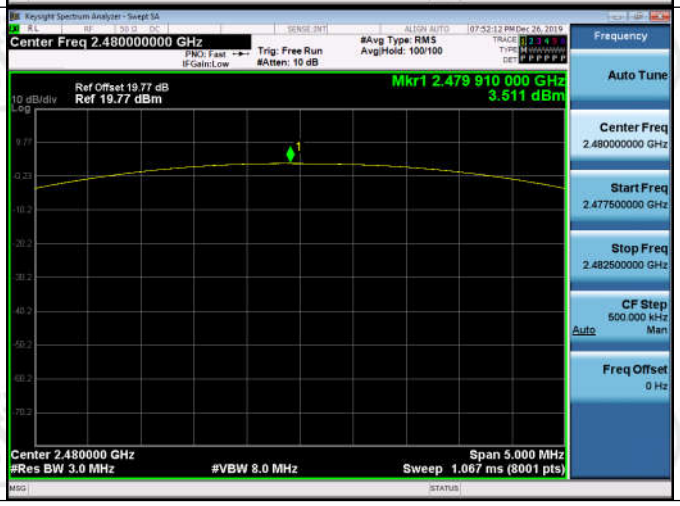
Test Setup

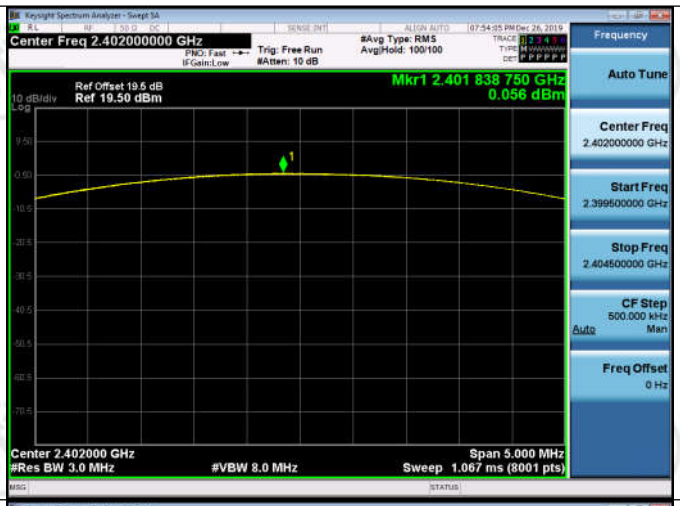
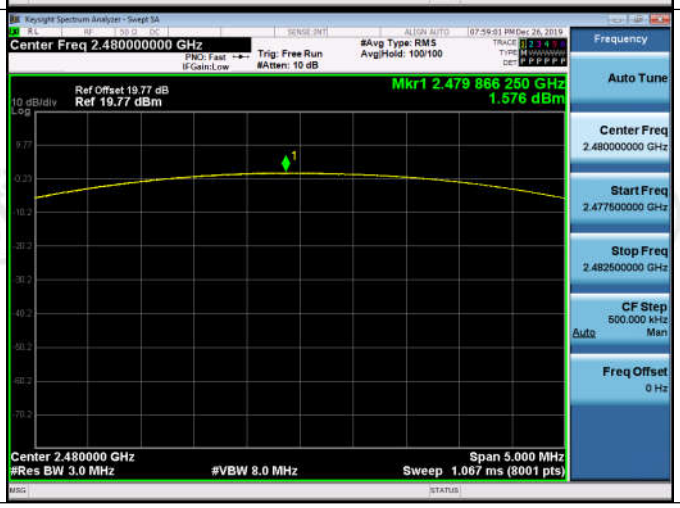


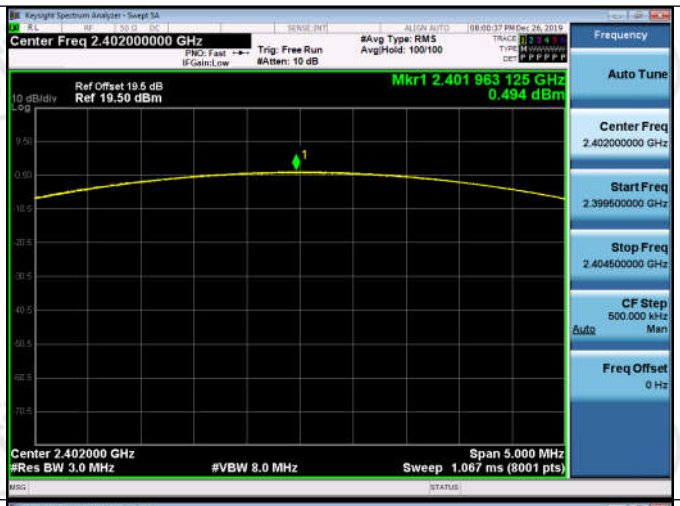
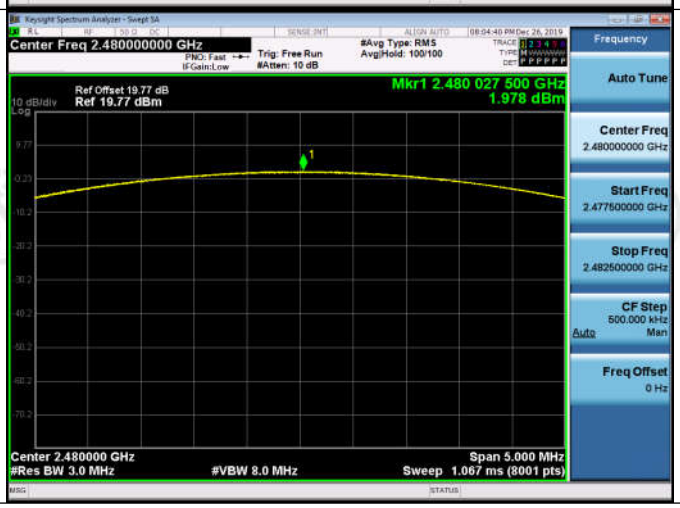
Result Table

Mode	Channel.	Maximum Peak Output Power [dBm]	Verdict
GFSK	LCH	2.224	PASS
GFSK	MCH	3.833	PASS
GFSK	HCH	3.511	PASS
π/4DQPSK	LCH	0.056	PASS
π/4DQPSK	MCH	1.947	PASS
π/4DQPSK	HCH	1.576	PASS
8DPSK	LCH	0.494	PASS
8DPSK	MCH	2.332	PASS
8DPSK	HCH	1.978	PASS

Test Graph

Graphs			
GFSK/LCH			
GFSK/MCH			
GFSK/HCH			

π/4DQPSK/LCH			
π/4DQPSK/MCH			
π/4DQPSK/HCH			

8DPSK/LCH			
8DPSK/MCH			
8DPSK/HCH			

Appendix F): Band-edge for RF Conducted Emissions

Test Limit

According to §15.247(d),

Limit	-20 dBc

.

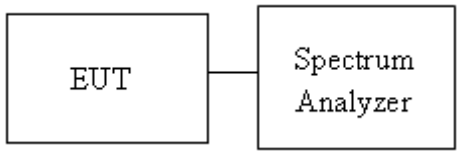
Test Procedure

1. EUT RF output port connected to the SA by RF cable, and the path loss was compensated to result.

2. SA setting, RBW=100kHz, VBW=300kHz, Detector=Peak, Trace mode = max hold, SWT = Auto.

3. The Band Edge at 2.4GHz and 2.4835GHz are investigated with normal hopping mode.

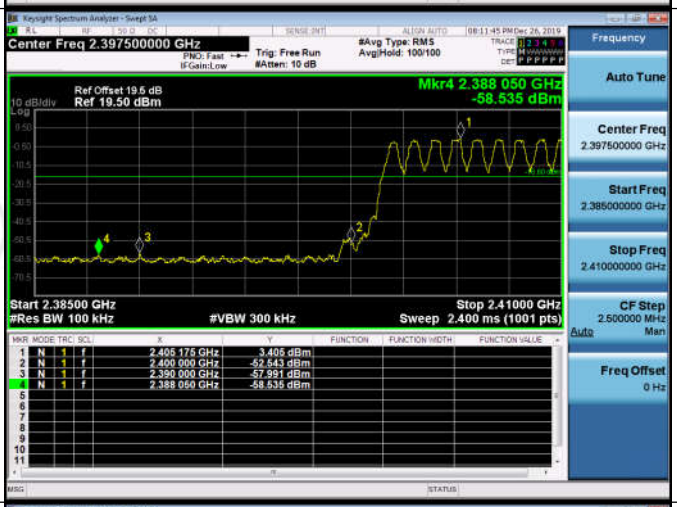
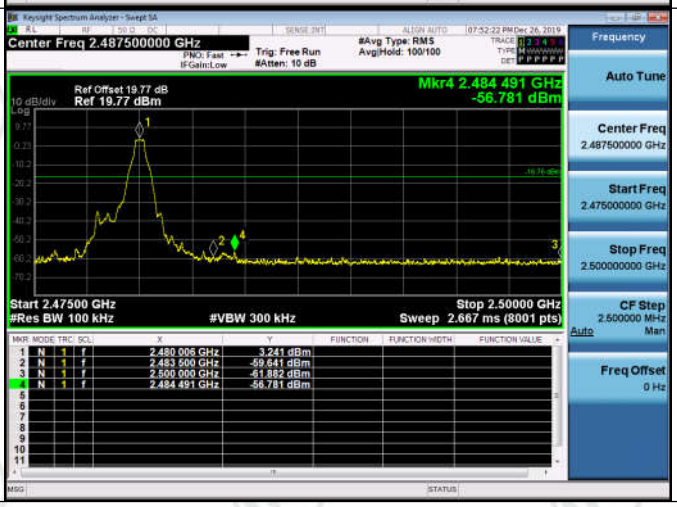
Test Setup

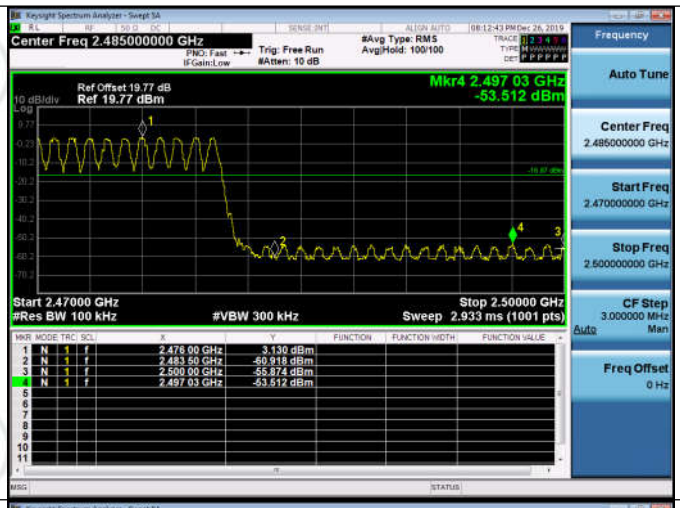
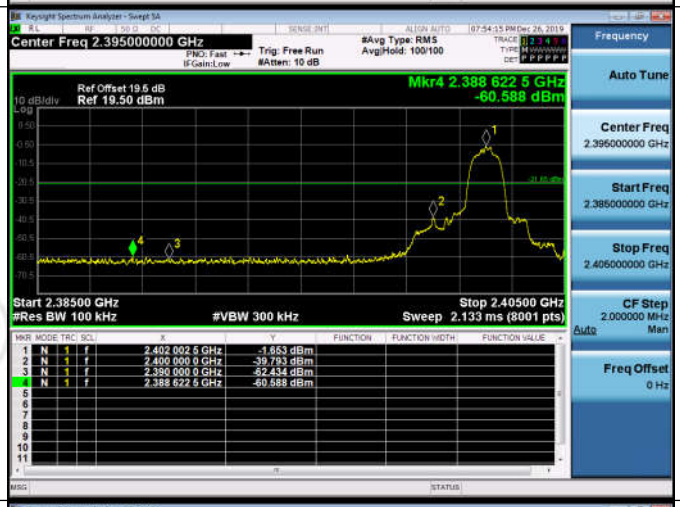


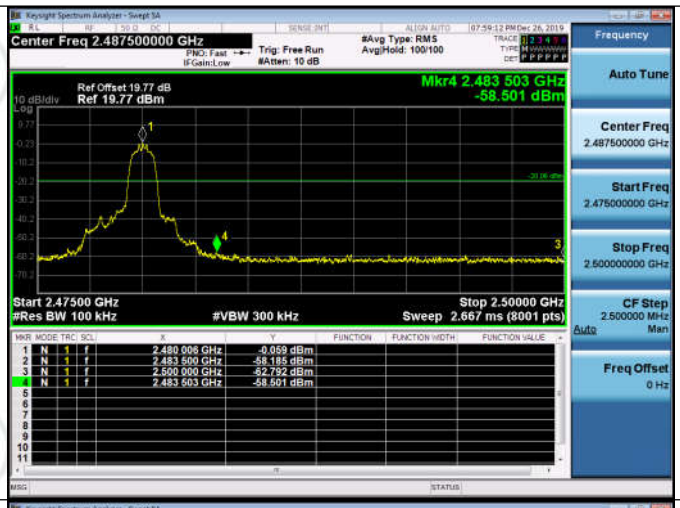
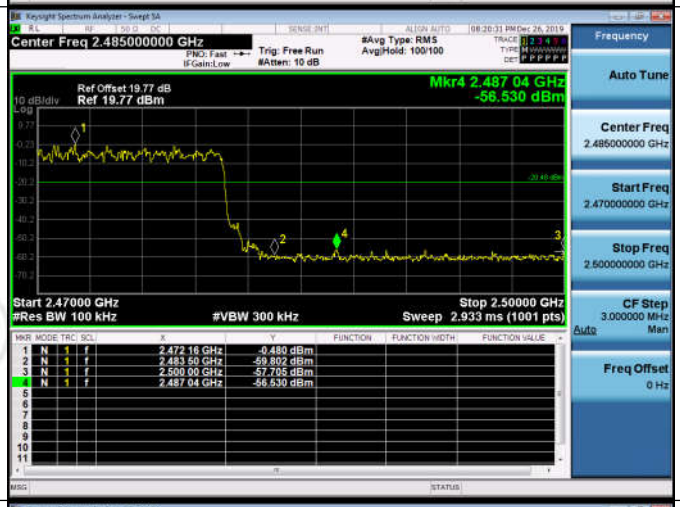
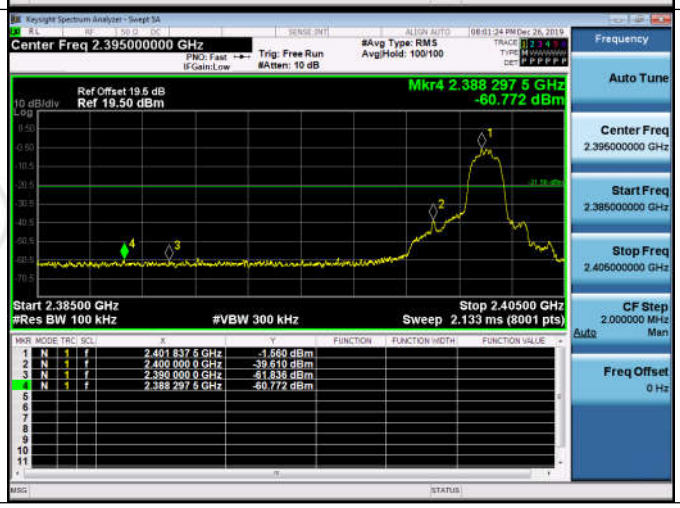
Result Table

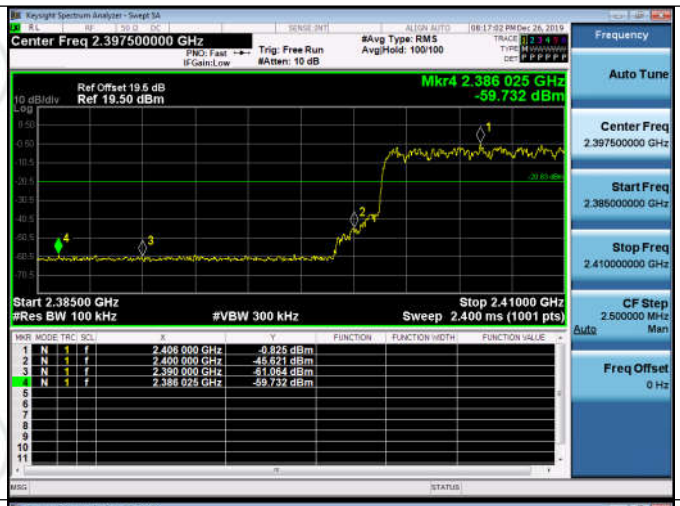
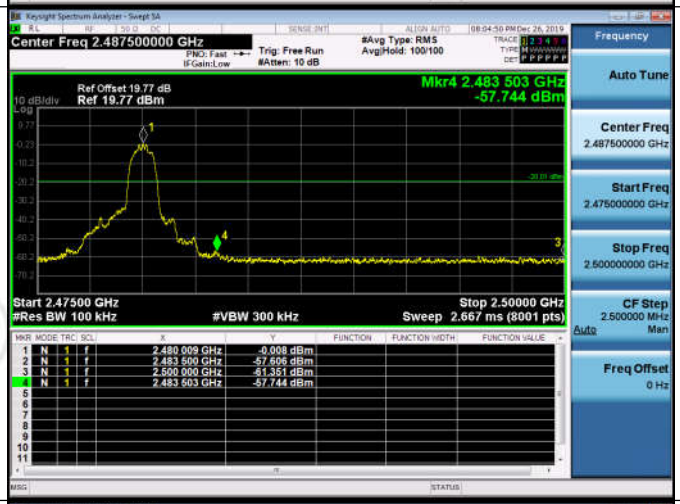
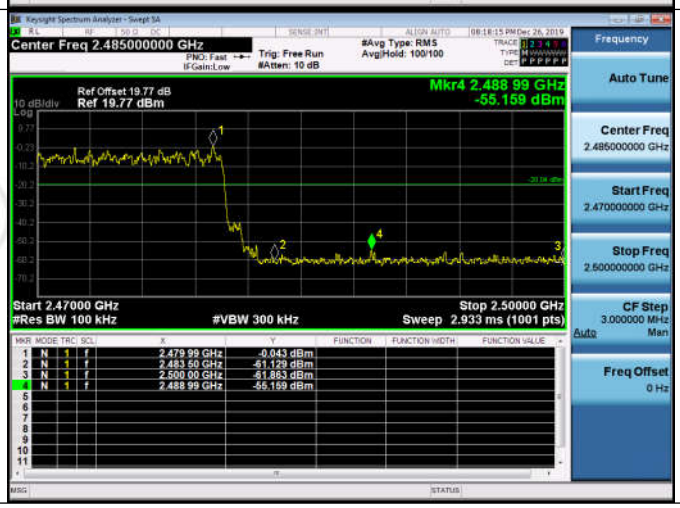
Mode	Channel	Carrier Frequency [MHz]	Carrier Power [dBm]	Frequency Hopping	Max Spurious Level [dBm]	Limit [dBm]	Verdict
GFSK	LCH	2402	1.952	Off	-60.587	-18.05	PASS
			3.405	On	-58.535	-16.6	PASS
GFSK	HCH	2480	3.241	Off	-56.781	-16.76	PASS
			3.130	On	-53.512	-16.87	PASS
π/4DQPSK	LCH	2402	-1.653	Off	-60.588	-21.65	PASS
			0.117	On	-60.185	-19.88	PASS
π/4DQPSK	HCH	2480	-0.059	Off	-58.501	-20.06	PASS
			-0.480	On	-56.530	-20.48	PASS
8DPSK	LCH	2402	-1.560	Off	-60.772	-21.56	PASS
			-0.825	On	-59.732	-20.83	PASS
8DPSK	HCH	2480	-0.008	Off	-57.744	-20.01	PASS
			-0.043	On	-55.159	-20.04	PASS

Test Graph

Graphs			
GFSK/LCH/No Hop			
GFSK/LCH/Hop			
GFSK/HCH/No Hop			

GFSK/HCH/Hop			
π/4DQPSK/LCH/No Hop			
π/4DQPSK/LCH/Hop			

π/4DQPSK/HCH/No Hop			
π/4DQPSK/HCH/Hop			
8DPSK/LCH/No Hop			

8DPSK/LCH/Hop			
8DPSK/HCH/No Hop			
8DPSK/HCH/Hop			

Appendix G): RF Conducted Spurious Emissions

Test Limit

According to §15.247(d),

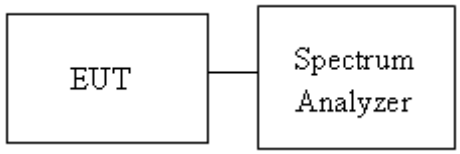
Limit	-20 dBc

Test Procedure

1. EUT RF output port connected to the SA by RF cable, and the path loss was compensated to result.

2. SA setting, RBW=100kHz, VBW=300kHz, Detector=Peak, Trace mode = max hold, SWT = Auto.

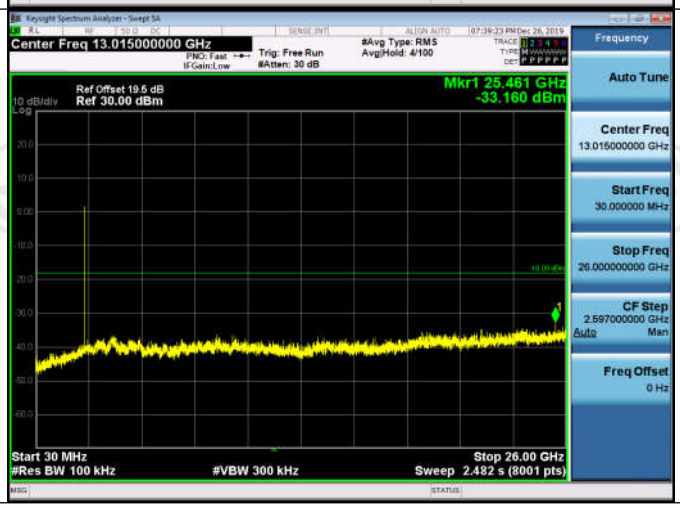
Test Setup

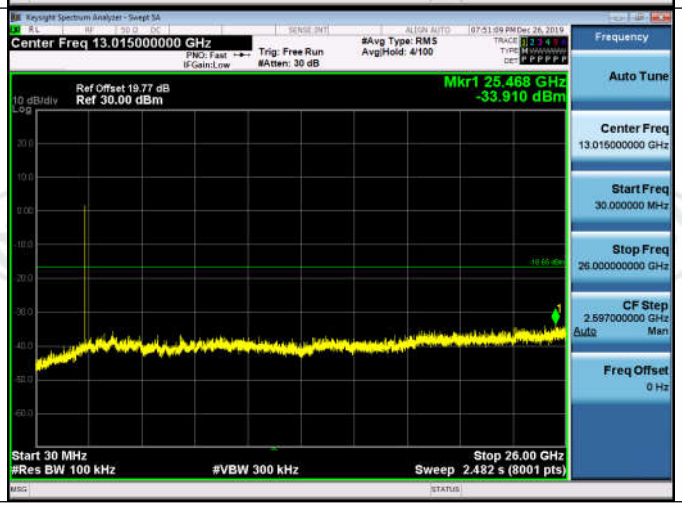


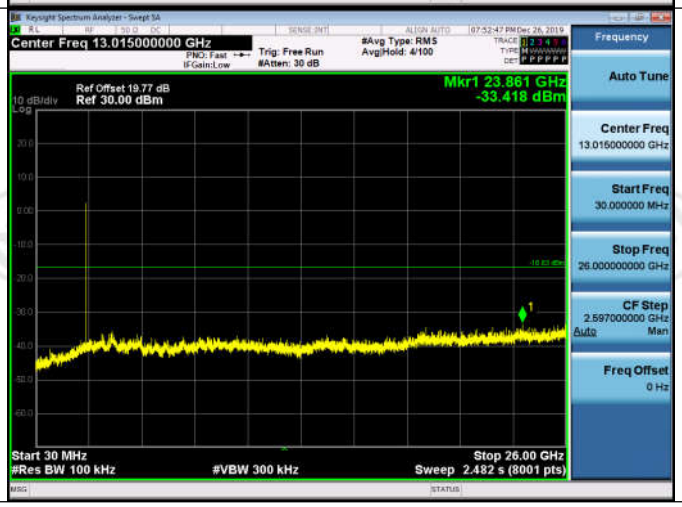
Result Table

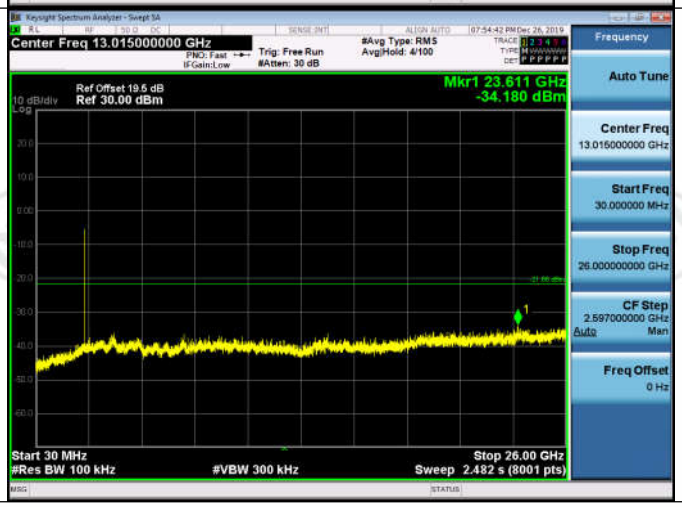
Mode	Channel	Pref [dBm]	Puw[dBm]	Verdict
GFSK	LCH	1.912	<Limit	PASS
GFSK	MCH	3.355	<Limit	PASS
GFSK	HCH	3.17	<Limit	PASS
π/4DQPSK	LCH	-1.661	<Limit	PASS
π/4DQPSK	MCH	0.25	<Limit	PASS
π/4DQPSK	HCH	-0.096	<Limit	PASS
8DPSK	LCH	-1.581	<Limit	PASS
8DPSK	MCH	0.355	<Limit	PASS
8DPSK	HCH	-0.105	<Limit	PASS

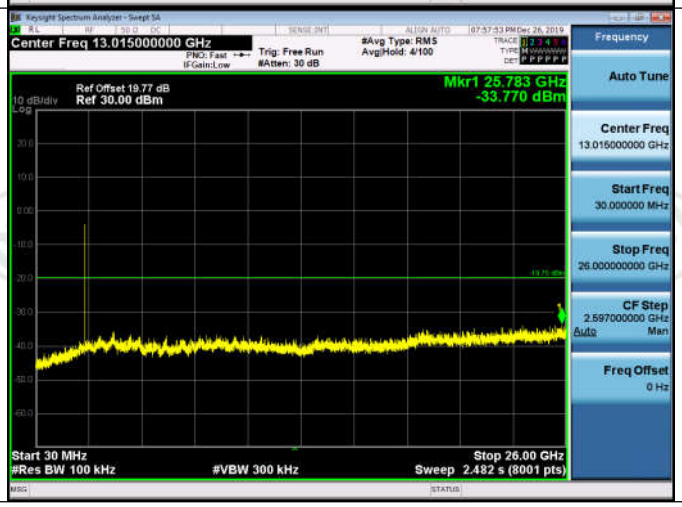
Test Graph

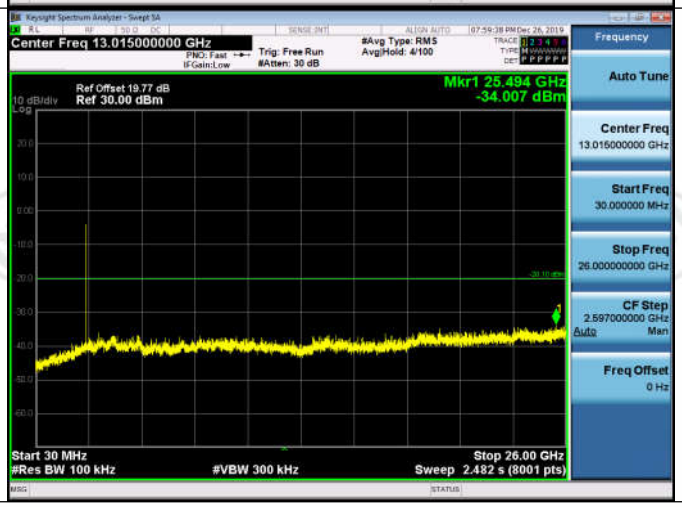
GFSK_LCH_Graphs			
Pref			
Puw			

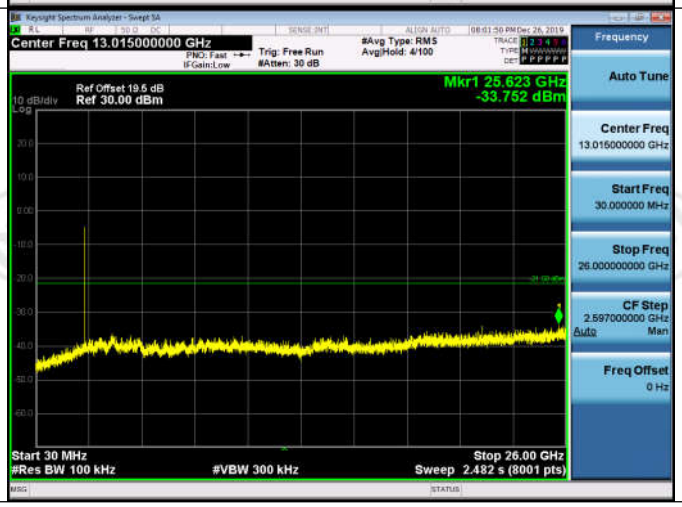
GFSK_MCH_Graphs			
Pref			
Puw			

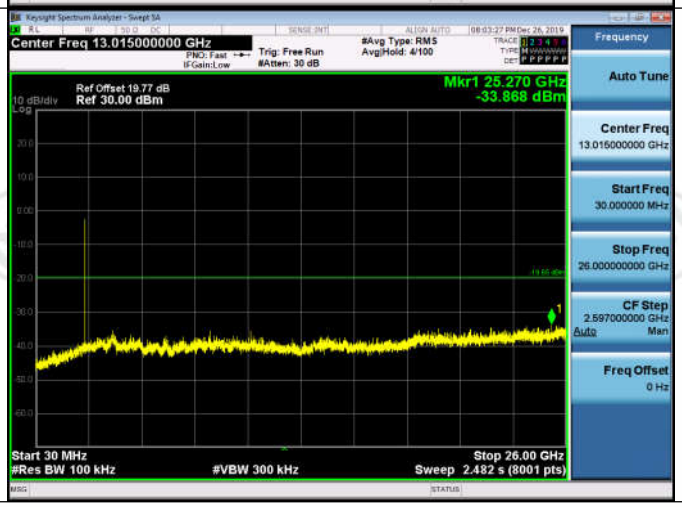
GFSK_HCH_Graphs			
Pref			
Puw			

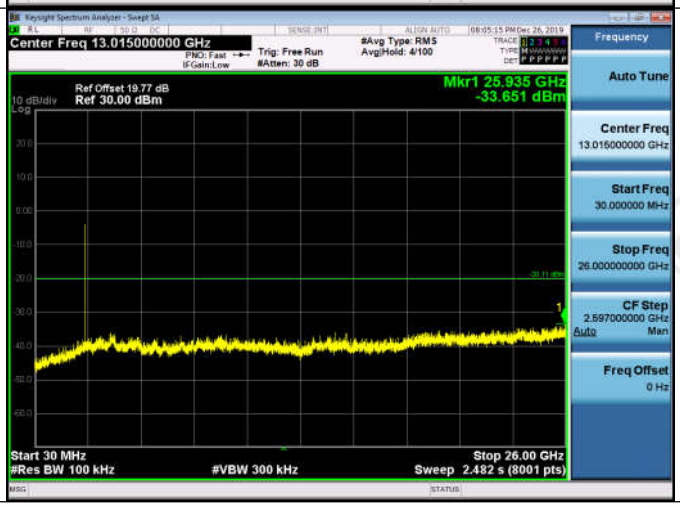
π/4DQPSK_LCH_Graphs			
Pref			
Puw			

π/4DQPSK_MCH_Graphs			
Pref			
Puw			

π/4DQPSK_HCH_Graphs			
Pref			
Puw			

8DPSK_LCH_Graphs			
Pref			
Puw			

8DPSK_MCH_Graphs			
Pref			
Puw			

8DPSK_HCH_Graphs			
Pref			
Puw			

Appendix H) Pseudorandom Frequency Hopping Sequence

Test Requirement:	47 CFR Part 15**C Section 15.247 (a)(1) requirement:**

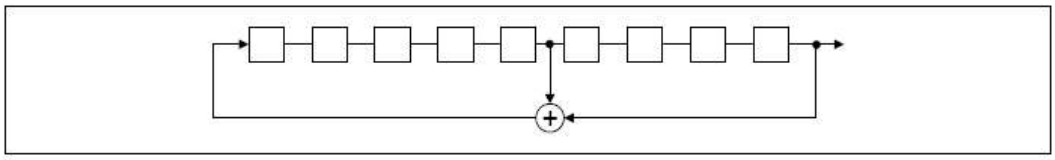
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Alternatively. Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

EUT Pseudorandom Frequency Hopping Sequence

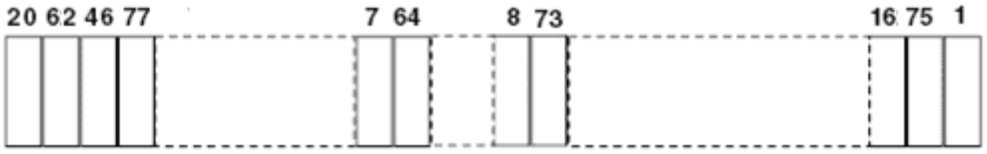
The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 2^9 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



Each frequency used equally on the average by each transmitter.

The system receivers have input bandwidths that match the hopping channel bandwidths of their Corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

The device does not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Appendix I) Antenna Requirement

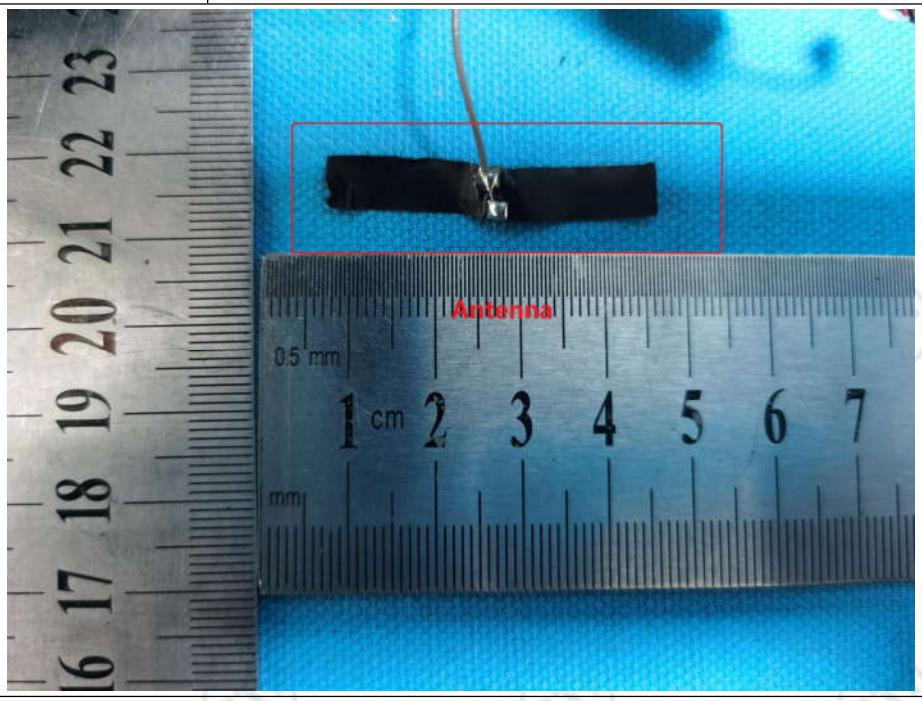
15.203 requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

15.247(b) (4) requirement:

The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

EUT Antenna:



The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is 1dBi.

Appendix J) AC Power Line Conducted Emission

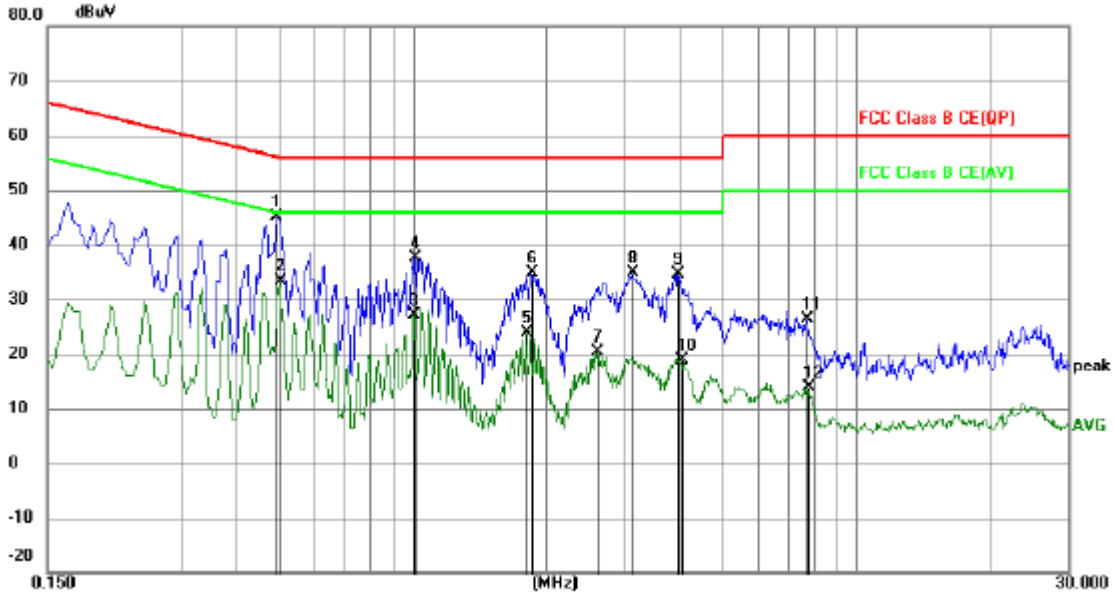
<table>
<tr><td>Test Procedure:</td><td>Test frequency range :150KHz-30MHz
1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.</td></tr>
<tr><td>Limit:</td><td>
<table>
<tr><td rowspan="2">Frequency range (MHz)</td><td colspan="2">Limit (dBuV)</td></tr>
<tr><td>Quasi-peak</td><td>Average</td></tr>
<tr><td>0.15-0.5</td><td>66 to 56*</td><td>56 to 46*</td></tr>
<tr><td>0.5-5</td><td>56</td><td>46</td></tr>
<tr><td>5-30</td><td>60</td><td>50</td></tr>
</table>
* The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.
NOTE : The lower limit is applicable at the transition frequency</td></tr>
</table>

Measurement Data

An initial pre-scan was performed on the live and neutral lines with peak detector.

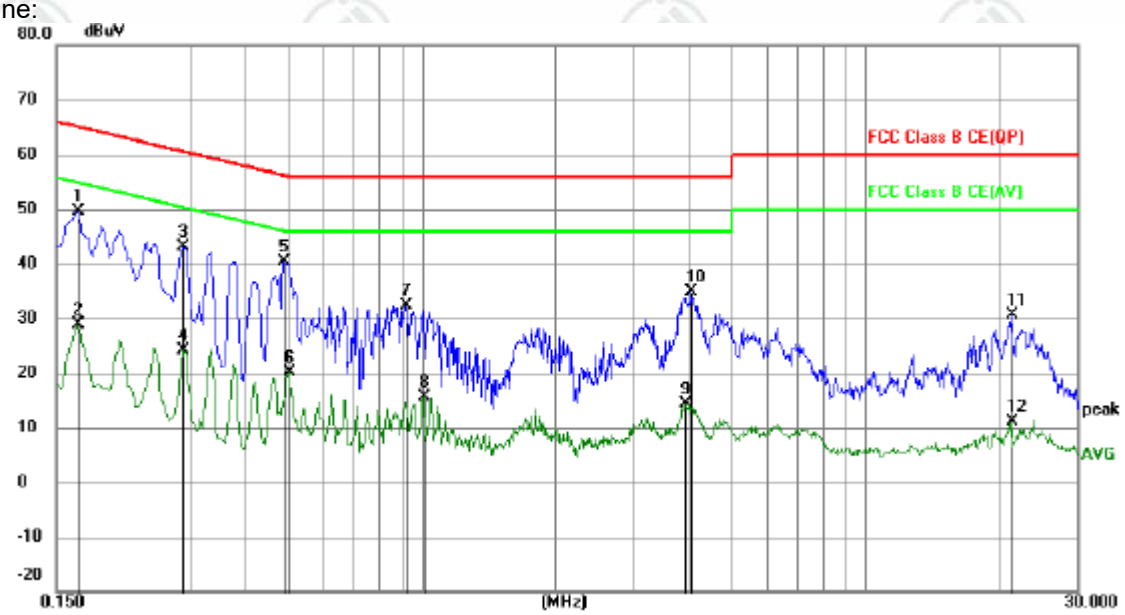
Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.

Live line:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.4920	35.17	10.00	45.17	56.13	-10.96	peak	
2		0.5010	23.34	10.00	33.34	46.00	-12.66	AVG	
3		1.0005	17.11	9.91	27.02	46.00	-18.98	AVG	
4		1.0050	27.62	9.91	37.53	56.00	-18.47	peak	
5		1.8015	13.91	9.85	23.76	46.00	-22.24	AVG	
6		1.8510	25.14	9.84	34.98	56.00	-21.02	peak	
7		2.6025	10.62	9.83	20.45	46.00	-25.55	AVG	
8		3.1290	24.95	9.83	34.78	56.00	-21.22	peak	
9		3.9525	24.81	9.83	34.64	56.00	-21.36	peak	
10		4.0290	9.03	9.83	18.86	46.00	-27.14	AVG	
11		7.7145	16.52	9.88	26.40	60.00	-33.60	peak	
12		7.7955	3.98	9.88	13.86	50.00	-36.14	AVG	

Neutral line:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1680	39.68	9.99	49.67	65.06	-15.39	peak	
2		0.1680	18.89	9.99	28.88	55.06	-26.18	AVG	
3		0.2895	33.00	10.09	43.09	60.54	-17.45	peak	
4		0.2895	14.11	10.09	24.20	50.54	-26.34	AVG	
5		0.4875	30.34	10.00	40.34	56.21	-15.87	peak	
6		0.5010	10.23	10.00	20.23	46.00	-25.77	AVG	
7		0.9195	22.38	9.92	32.30	56.00	-23.70	peak	
8		1.0050	5.83	9.91	15.74	46.00	-30.26	AVG	
9		3.9300	4.62	9.83	14.45	46.00	-31.55	AVG	
10		4.0380	25.01	9.83	34.84	56.00	-21.16	peak	
11		21.3900	20.61	9.94	30.55	60.00	-29.45	peak	
12		21.3900	1.19	9.94	11.13	50.00	-38.87	AVG	

Notes:

1. The following Quasi-Peak and Average measurements were performed on the EUT:

2. Final Test Level =Receiver Reading + LISN Factor + Cable Loss.

Appendix K) Restricted bands around fundamental frequency (Radiated)

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
30MHz-1GHz	Quasi-peak	120 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Test Procedure:

Below 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
f. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance. Also measure any emissions in the restricted bands. Save the spectrum analyzer plot. Repeat for each power and modulation for lowest and highest channel

Above 1GHz test procedure as below:

g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 metre to 1.5 metre(Above 18GHz the distance is 1 meter and table is 1.5 metre).
h. b. Test the EUT in the lowest channel , the Highest channel
i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is worse case.
j. Repeat above procedures until all frequencies measured was complete.

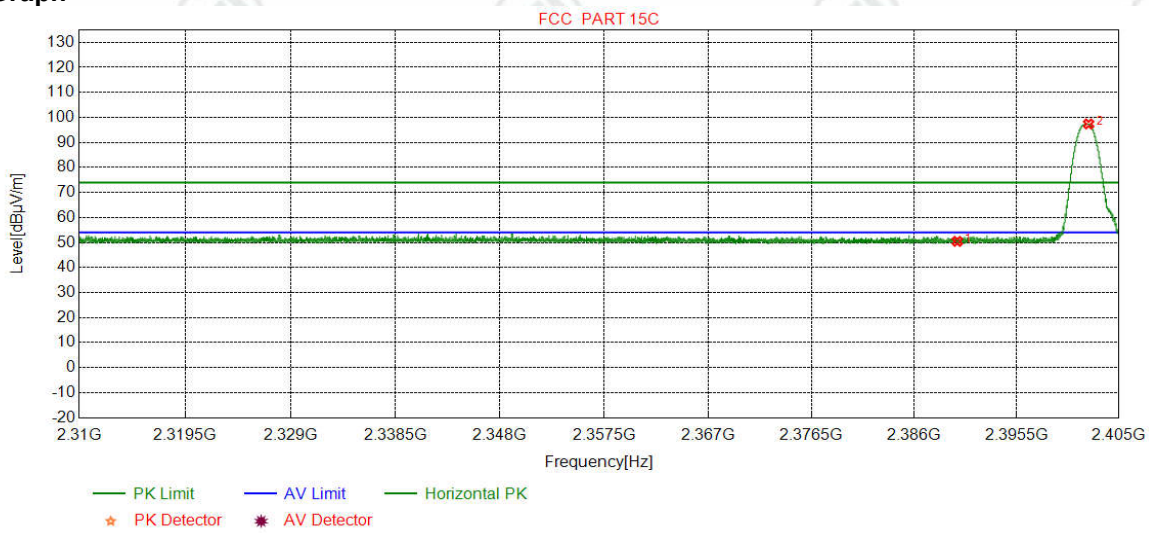
Limit:

Frequency	Limit (dBuV/m @3m)	Remark
30MHz-88MHz	40.0	Quasi-peak Value
88MHz-216MHz	43.5	Quasi-peak Value
216MHz-960MHz	46.0	Quasi-peak Value
960MHz-1GHz	54.0	Quasi-peak Value
Above 1GHz	54.0	Average Value
	74.0	Peak Value

Test plot as follows:

Mode:	GFSK Transmitting	Channel:	2402
Remark:	PK		

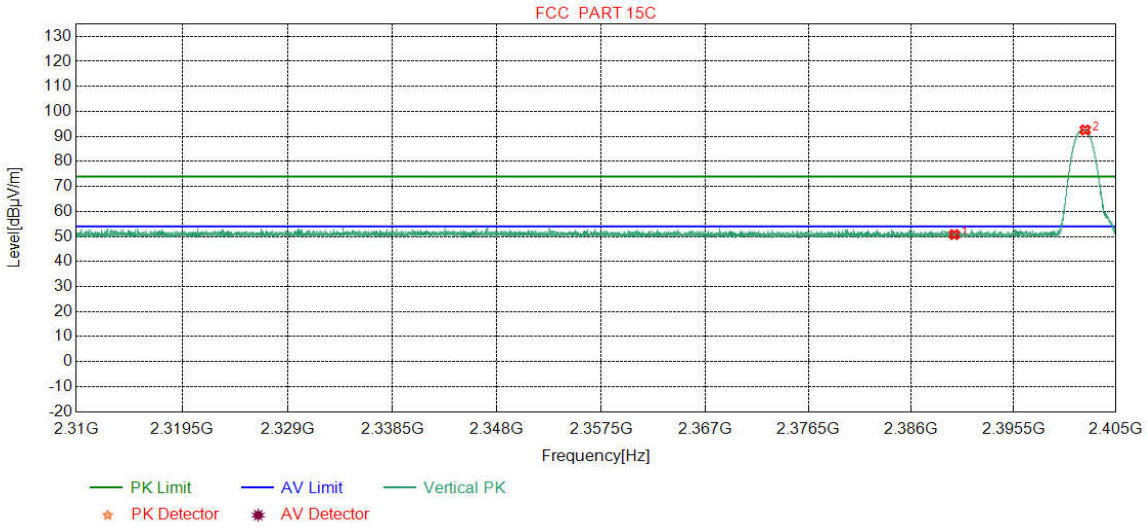
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	47.95	50.45	74.00	23.55	Pass	Horizontal
2	2402.1941	32.26	13.31	-43.12	94.93	97.38	74.00	-23.38	Pass	Horizontal

Mode:	GFSK Transmitting	Channel:	2402
Remark:	PK		

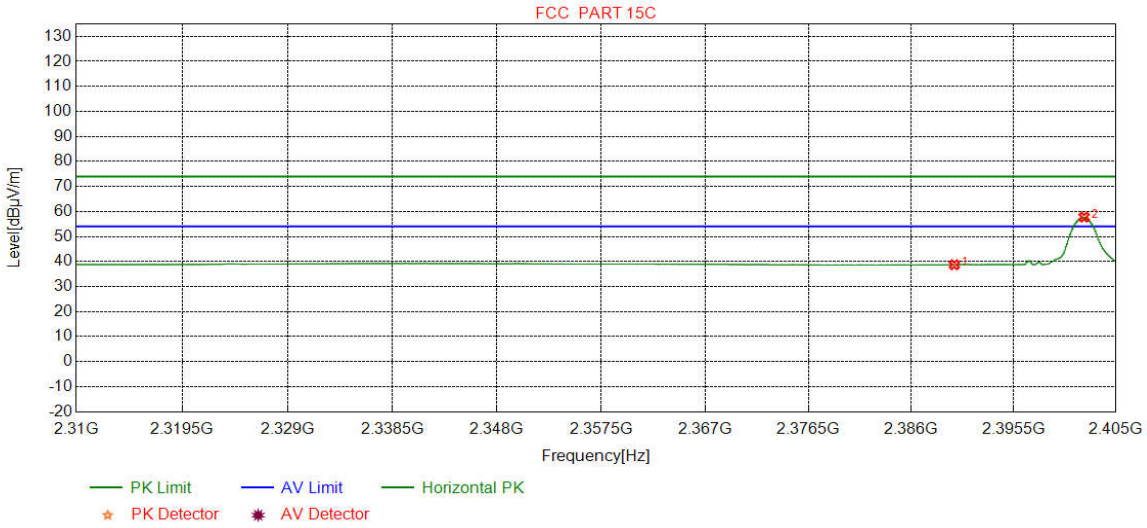
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	48.27	50.77	74.00	23.23	Pass	Vertical
2	2402.1498	32.26	13.31	-43.12	90.14	92.59	74.00	-18.59	Pass	Vertical

Mode:	GFSK Transmitting	Channel:	2402
Remark:	AV		

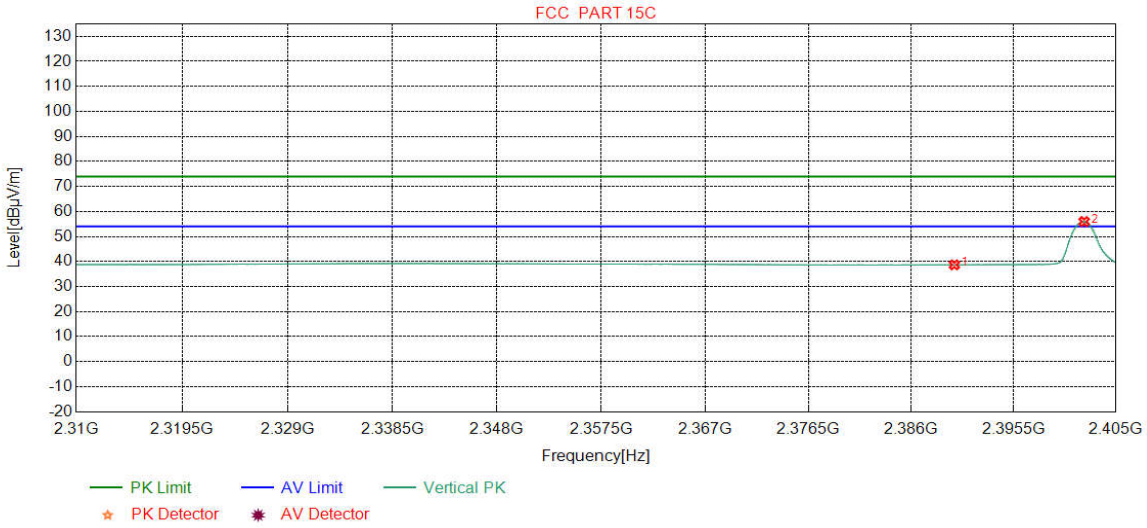
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	36.20	38.70	54.00	15.30	Pass	Horizontal
2	2402.0485	32.26	13.31	-43.12	55.31	57.76	54.00	-3.76	Pass	Horizontal

Mode:	GFSK Transmitting	Channel:	2402
Remark:	AV		

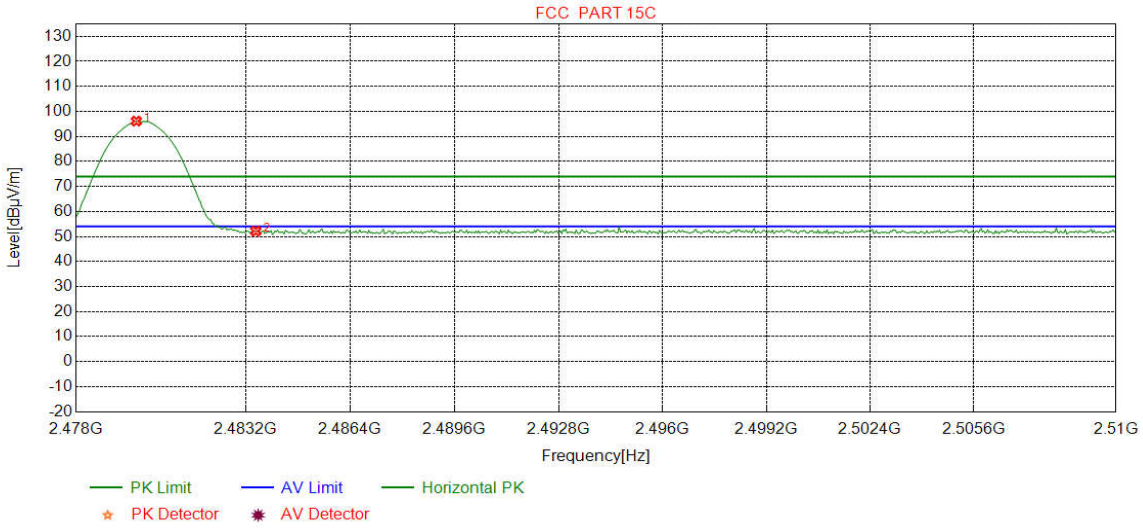
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	36.17	38.67	54.00	15.33	Pass	Vertical
2	2402.0548	32.26	13.31	-43.12	53.53	55.98	54.00	-1.98	Pass	Vertical

Mode:	GFSK Transmitting	Channel:	2480
Remark:	PK		

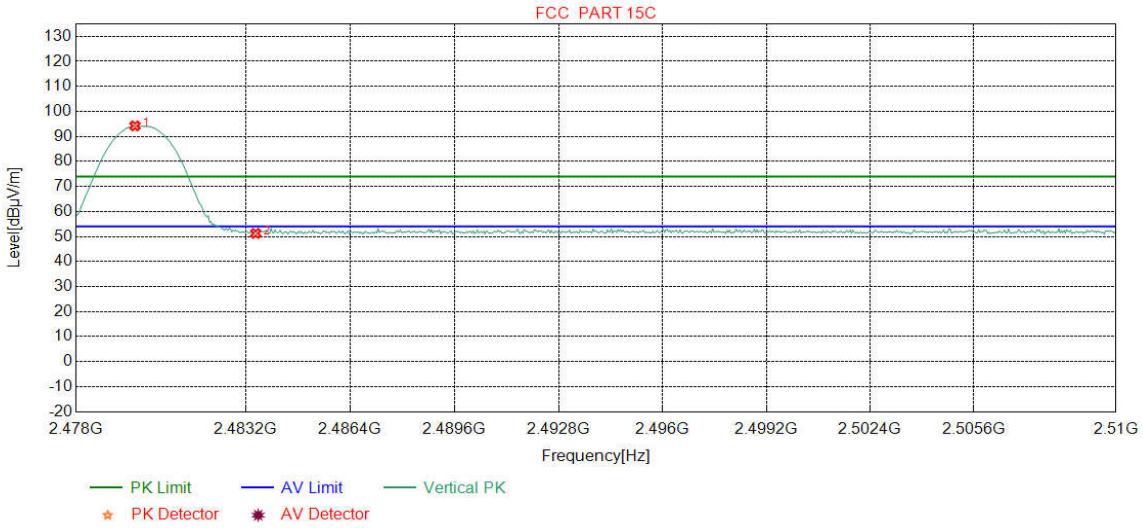
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2479.8423	32.37	13.39	-43.10	93.47	96.13	74.00	-22.13	Pass	Horizontal
2	2483.5000	32.38	13.38	-43.11	49.51	52.16	74.00	21.84	Pass	Horizontal

Mode:	GFSK Transmitting	Channel:	2480
Remark:	PK		

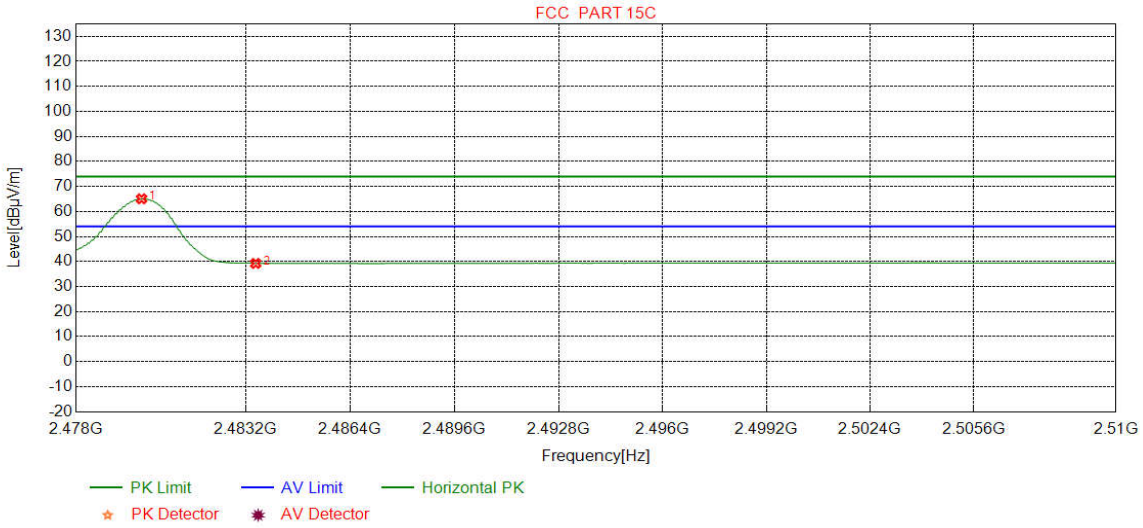
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2479.8023	32.37	13.39	-43.10	91.56	94.22	74.00	-20.22	Pass	Vertical
2	2483.5000	32.38	13.38	-43.11	48.59	51.24	74.00	22.76	Pass	Vertical

Mode:	GFSK Transmitting	Channel:	2480
Remark:	AV		

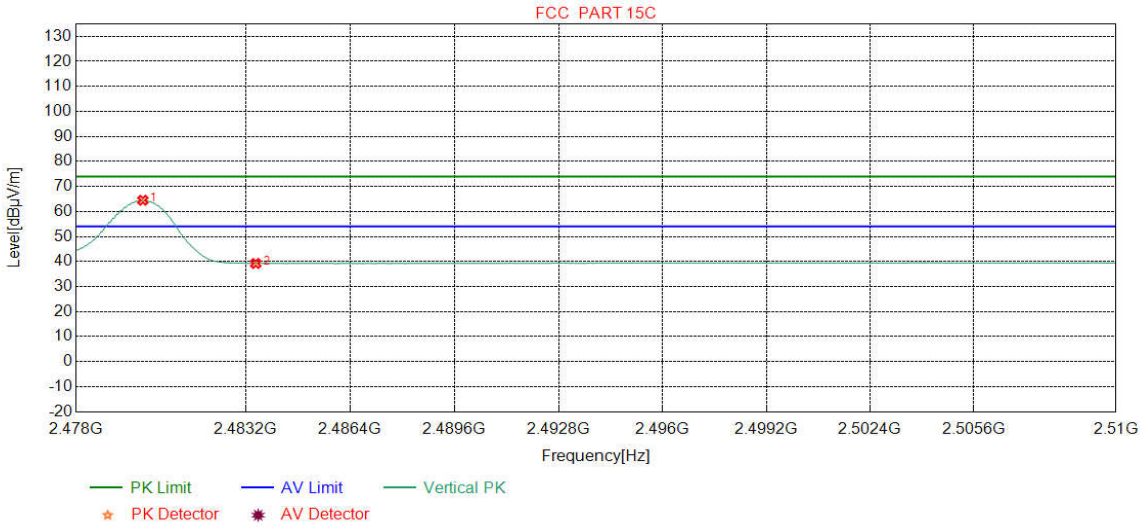
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2480.0025	32.37	13.39	-42.39	61.69	65.06	54.00	-11.06	Pass	Horizontal
2	2483.5000	32.38	13.38	-42.40	35.89	39.25	54.00	14.75	Pass	Horizontal

Mode:	GFSK Transmitting	Channel:	2480
Remark:	AV		

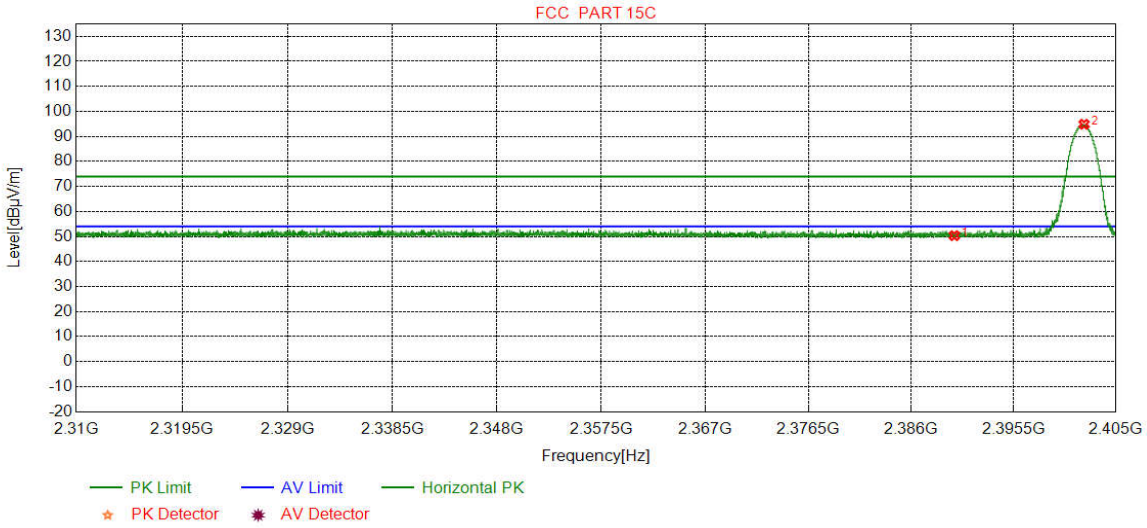
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2480.0426	32.37	13.39	-42.39	61.12	64.49	54.00	-10.49	Pass	Vertical
2	2483.5000	32.38	13.38	-42.40	35.88	39.24	54.00	14.76	Pass	Vertical

Mode:	8DPSK Transmitting	Channel:	2402
Remark:	PK		

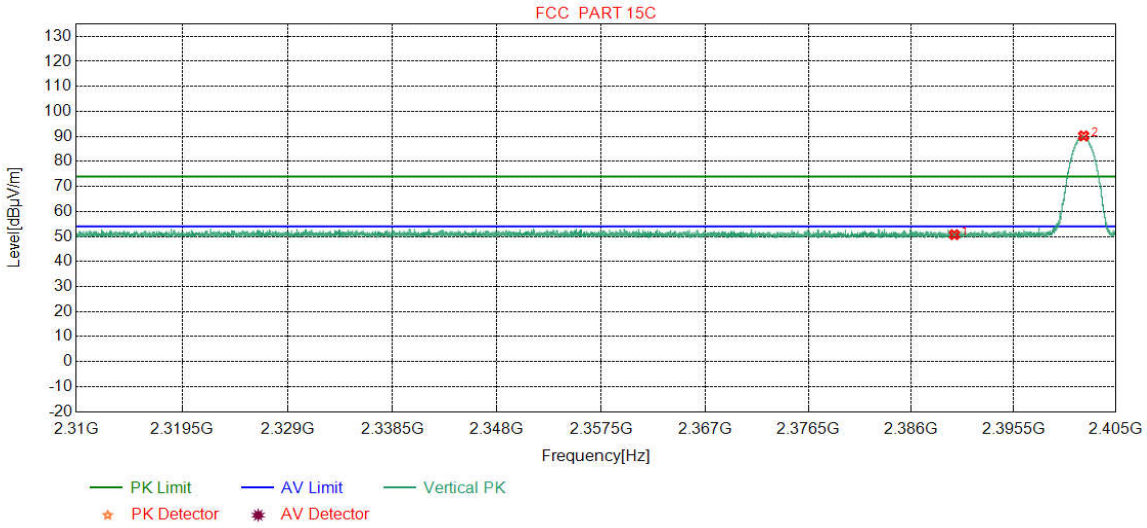
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	47.84	50.34	74.00	23.66	Pass	Horizontal
2	2402.0485	32.26	13.31	-43.12	92.42	94.87	74.00	-20.87	Pass	Horizontal

Mode:	8DPSK Transmitting	Channel:	2402
Remark:	PK		

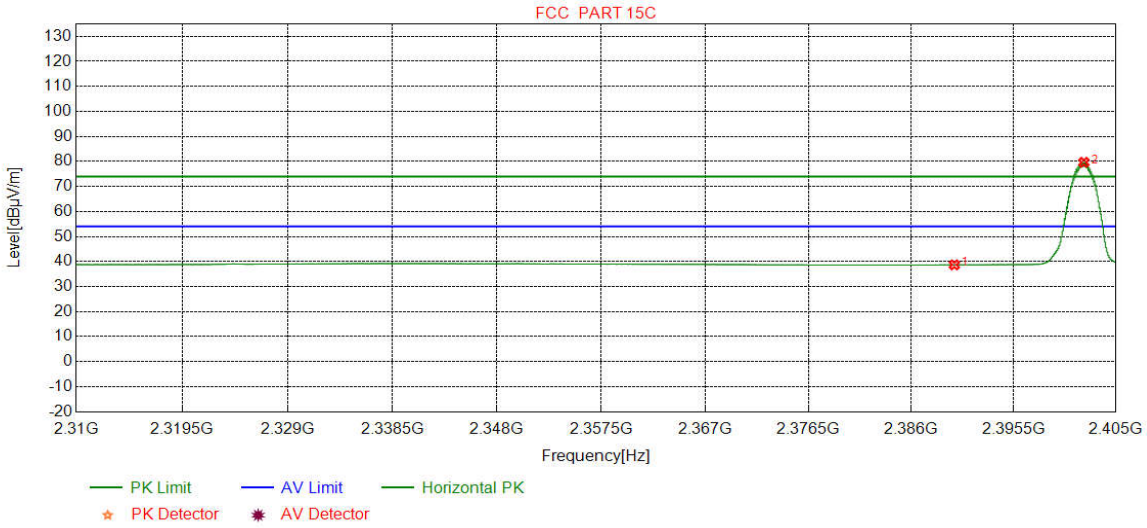
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	48.22	50.72	74.00	23.28	Pass	Vertical
2	2402.0105	32.26	13.31	-43.12	87.75	90.20	74.00	-16.20	Pass	Vertical

Mode:	8DPSK Transmitting	Channel:	2402
Remark:	AV		

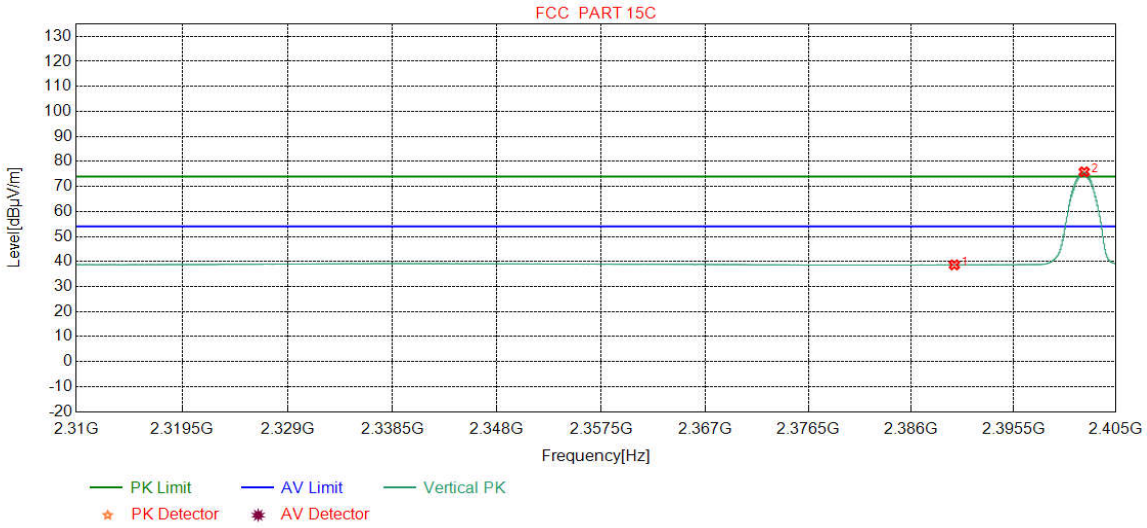
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	36.18	38.68	54.00	15.32	Pass	Horizontal
2	2402.0295	32.26	13.31	-43.12	77.20	79.65	54.00	-25.65	Pass	Horizontal

Mode:	8DPSK Transmitting	Channel:	2402
Remark:	AV		

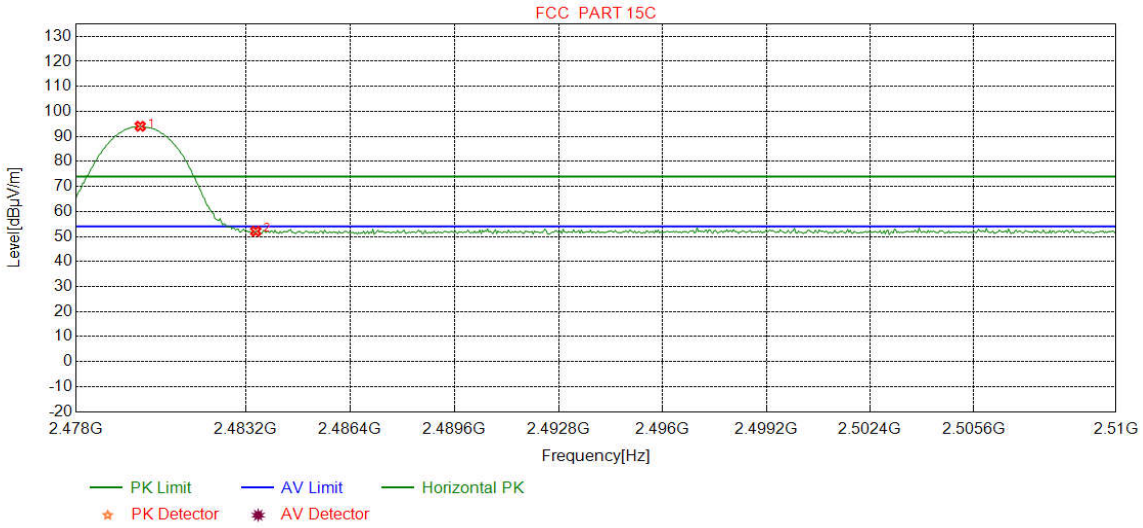
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2390.0000	32.25	13.37	-43.12	36.16	38.66	54.00	15.34	Pass	Vertical
2	2402.0611	32.26	13.31	-43.12	73.39	75.84	54.00	-21.84	Pass	Vertical

Mode:	8DPSK Transmitting	Channel:	2480
Remark:	PK		

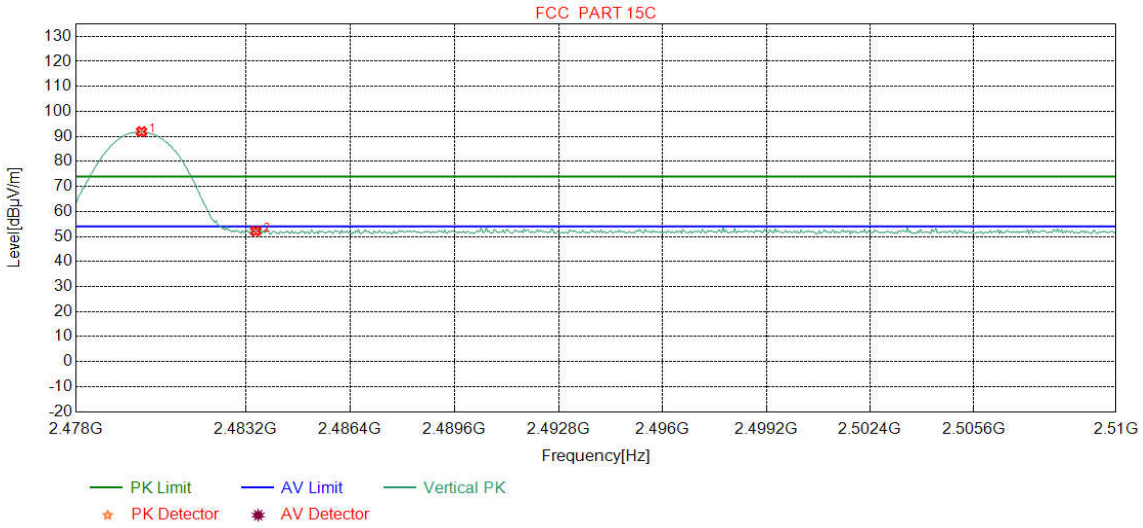
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2479.9625	32.37	13.39	-43.10	91.41	94.07	74.00	-20.07	Pass	Horizontal
2	2483.5000	32.38	13.38	-43.11	49.45	52.10	74.00	21.90	Pass	Horizontal

Mode:	8DPSK Transmitting	Channel:	2480
Remark:	PK		

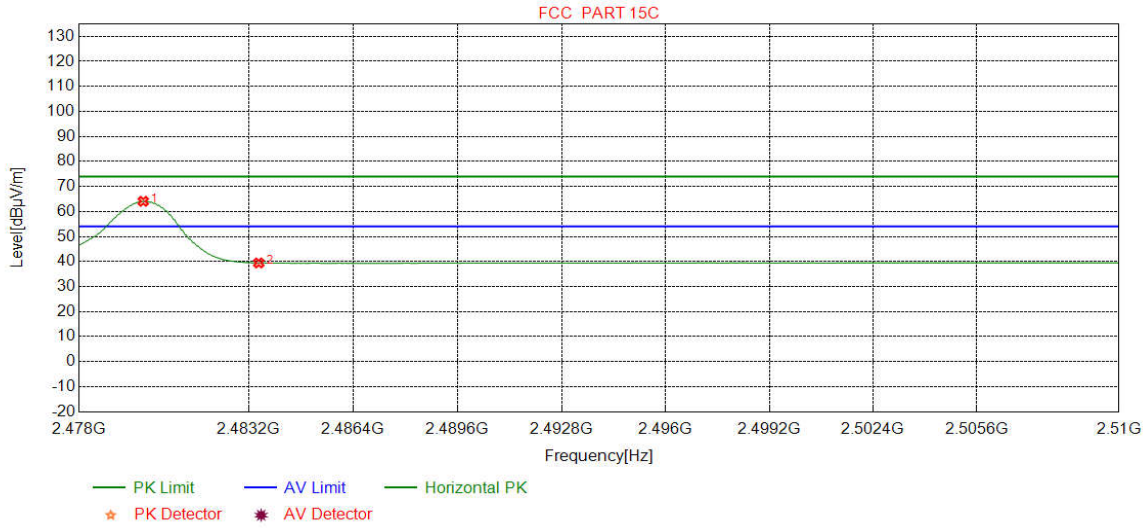
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2480.0025	32.37	13.39	-43.10	89.25	91.91	74.00	-17.91	Pass	Vertical
2	2483.5000	32.38	13.38	-43.11	49.52	52.17	74.00	21.83	Pass	Vertical

Mode:	8DPSK Transmitting	Channel:	2480
Remark:	AV		

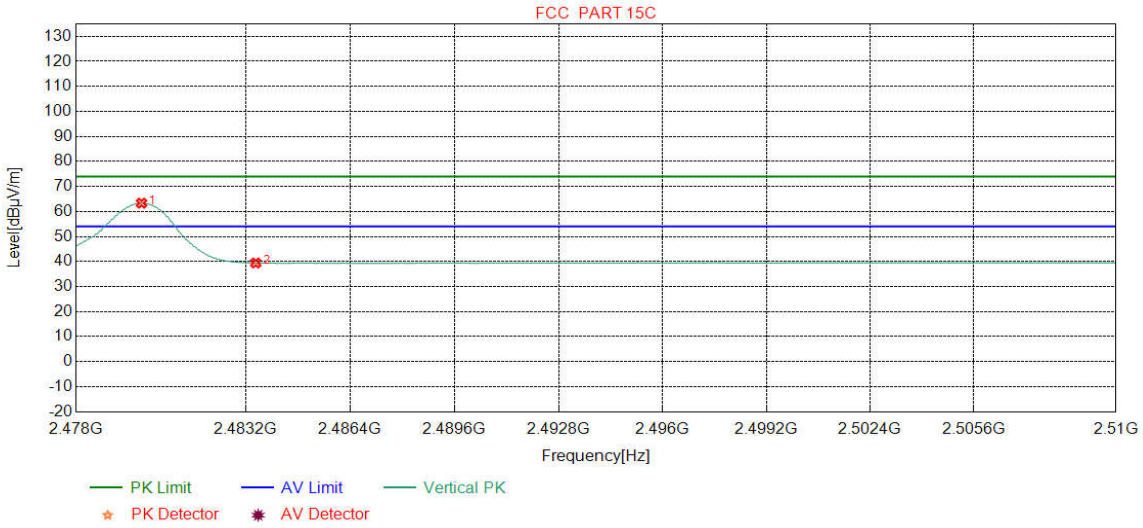
Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2479.9625	32.37	13.39	-42.39	60.68	64.05	54.00	-10.05	Pass	Horizontal
2	2483.5000	32.38	13.38	-42.40	36.07	39.43	54.00	14.57	Pass	Horizontal

Mode:	8DPSK Transmitting	Channel:	2480
Remark:	AV		

Test Graph



NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity
1	2480.0025	32.37	13.39	-42.39	59.98	63.35	54.00	-9.35	Pass	Vertical
2	2483.5000	32.38	13.38	-42.40	36.05	39.41	54.00	14.59	Pass	Vertical

Note:

1) Through Pre-scan Non-hopping transmitting mode and charge+transmitter mode with all kind of modulation and all kind of data type, find the DH5 of data type is the worse case of GFSK modulation type in charge + transmitter mode.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading - Correct Factor

Correct Factor = Preamplifier Factor– Antenna Factor–Cable Factor

Appendix L) Radiated Spurious Emissions

Receiver Setup:

Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30kHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30kHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30kHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30kHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300kHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

Test Procedure:

Below 1GHz test procedure as below:

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 metre to 1.5 metre(Above 18GHz the distance is 1 meter and table is 1.5 metre).

h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is worse case.

j. Repeat above procedures until all frequencies measured was complete.

Limit:

Frequency	Field strength (microvolt/meter)	Limit (dBuV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency

	emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

Radiated Spurious Emissions test Data:

Radiated Emission below 1GHz

Mode:			GFSK Transmitting					Channel:		2441	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	62.9833	10.82	0.91	-31.87	47.80	27.66	40.00	12.34	Pass	H	PK
2	87.1387	8.74	1.08	-32.04	58.22	36.00	40.00	4.00	Pass	H	PK
3	156.0156	7.76	1.46	-31.99	58.67	35.90	43.50	7.60	Pass	H	PK
4	224.0194	11.52	1.78	-31.93	49.04	30.41	46.00	15.59	Pass	H	PK
5	600.0290	19.00	2.96	-31.50	45.09	35.55	46.00	10.45	Pass	H	PK
6	974.9715	22.55	3.75	-30.95	41.17	36.52	54.00	17.48	Pass	H	PK
7	65.0205	10.29	0.92	-31.92	41.42	20.71	40.00	19.29	Pass	V	PK
8	90.2430	9.44	1.10	-32.09	49.55	28.00	43.50	15.50	Pass	V	PK
9	152.0382	7.62	1.45	-32.00	47.83	24.90	43.50	18.60	Pass	V	PK
10	208.8859	11.13	1.71	-31.94	47.12	28.02	43.50	15.48	Pass	V	PK
11	600.0290	19.00	2.96	-31.50	44.75	35.21	46.00	10.79	Pass	V	PK
12	974.9715	22.55	3.75	-30.95	41.12	36.47	54.00	17.53	Pass	V	PK

Transmitter Emission above 1GHz

Mode:			GFSK Transmitting					Channel:		2402	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1598.0598	29.05	3.07	-42.91	55.29	44.50	74.00	29.50	Pass	H	PK
2	2126.1126	31.88	3.62	-43.18	59.57	51.89	74.00	22.11	Pass	H	PK
3	4804.1203	34.50	4.55	-42.80	59.58	55.83	74.00	18.17	Pass	H	PK
4	7206.0000	36.31	5.81	-42.16	51.49	51.45	74.00	22.55	Pass	H	PK
5	9608.0000	37.64	6.63	-42.10	47.49	49.66	74.00	24.34	Pass	H	PK
6	12010.0000	39.31	7.60	-41.90	46.08	51.09	74.00	22.91	Pass	H	PK
7	4804.0203	34.50	4.55	-42.80	52.29	48.54	54.00	5.46	Pass	H	AV
8	1062.8063	27.96	2.52	-43.03	55.18	42.63	74.00	31.37	Pass	V	PK
9	2132.7133	31.89	3.63	-43.18	60.26	52.60	74.00	21.40	Pass	V	PK
10	4804.1203	34.50	4.55	-42.80	58.07	54.32	74.00	19.68	Pass	V	PK
11	7206.0000	36.31	5.81	-42.16	49.50	49.46	74.00	24.54	Pass	V	PK
12	9608.0000	37.64	6.63	-42.10	47.92	50.09	74.00	23.91	Pass	V	PK
13	12010.0000	39.31	7.60	-41.90	45.84	50.85	74.00	23.15	Pass	V	PK
14	4804.0403	34.50	4.55	-42.80	50.93	47.18	54.00	6.82	Pass	V	AV

Mode:			GFSK Transmitting					Channel:		2441	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1063.8064	27.96	2.52	-43.03	54.20	41.65	74.00	32.35	Pass	H	PK
2	2125.7126	31.88	3.62	-43.18	55.77	48.09	74.00	25.91	Pass	H	PK
3	4882.1255	34.50	4.81	-42.80	57.94	54.45	74.00	19.55	Pass	H	PK
4	7323.0000	36.42	5.85	-42.13	51.17	51.31	74.00	22.69	Pass	H	PK
5	9764.0000	37.71	6.71	-42.10	46.98	49.30	74.00	24.70	Pass	H	PK
6	12205.0000	39.42	7.67	-41.89	46.34	51.54	74.00	22.46	Pass	H	PK
7	4882.0355	34.50	4.81	-42.80	41.40	37.91	54.00	16.09	Pass	H	AV
8	1066.2066	27.97	2.53	-43.04	55.38	42.84	74.00	31.16	Pass	V	PK
9	1791.6792	30.33	3.31	-42.72	56.16	47.08	74.00	26.92	Pass	V	PK
10	4882.0000	34.50	4.81	-42.80	53.92	50.43	74.00	23.57	Pass	V	PK
11	7323.0000	36.42	5.85	-42.13	48.99	49.13	74.00	24.87	Pass	V	PK
12	9764.0000	37.71	6.71	-42.10	46.97	49.29	74.00	24.71	Pass	V	PK
13	12205.0000	39.42	7.67	-41.89	46.78	51.98	74.00	22.02	Pass	V	PK

Mode:			GFSK Transmitting					Channel:		2480	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1063.8064	27.96	2.52	-43.03	60.03	47.48	74.00	26.52	Pass	H	PK
2	2129.1129	31.88	3.62	-43.17	61.60	53.93	74.00	20.07	Pass	H	PK
3	4960.0000	34.50	4.82	-42.80	55.21	51.73	74.00	22.27	Pass	H	PK
4	7440.0000	36.54	5.85	-42.11	49.70	49.98	74.00	24.02	Pass	H	PK
5	9920.0000	37.77	6.79	-42.10	46.43	48.89	74.00	25.11	Pass	H	PK
6	12400.0000	39.54	7.86	-41.90	47.21	52.71	74.00	21.29	Pass	H	PK
7	1064.4064	27.96	2.52	-43.02	55.07	42.53	74.00	31.47	Pass	V	PK
8	2122.9123	31.87	3.61	-43.17	58.23	50.54	74.00	23.46	Pass	V	PK
9	4960.1307	34.50	4.82	-42.80	56.13	52.65	74.00	21.35	Pass	V	PK
10	7440.0000	36.54	5.85	-42.11	48.54	48.82	74.00	25.18	Pass	V	PK
11	9920.0000	37.77	6.79	-42.10	45.64	48.10	74.00	25.90	Pass	V	PK
12	12400.0000	39.54	7.86	-41.90	48.33	53.83	74.00	20.17	Pass	V	PK

Mode:			8DPSK Transmitting					Channel:		2402	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1063.8064	27.96	2.52	-43.03	57.63	45.08	74.00	28.92	Pass	H	PK
2	2127.1127	31.88	3.62	-43.18	57.25	49.57	74.00	24.43	Pass	H	PK
3	4804.0000	34.50	4.55	-42.80	54.49	50.74	74.00	23.26	Pass	H	PK
4	7206.0000	36.31	5.81	-42.16	47.99	47.95	74.00	26.05	Pass	H	PK
5	9608.0000	37.64	6.63	-42.10	47.54	49.71	74.00	24.29	Pass	H	PK
6	12010.0000	39.31	7.60	-41.90	47.68	52.69	74.00	21.31	Pass	H	PK
7	1062.4062	27.96	2.52	-43.03	53.28	40.73	74.00	33.27	Pass	V	PK
8	2123.9124	31.87	3.61	-43.17	57.41	49.72	74.00	24.28	Pass	V	PK
9	4804.0000	34.50	4.55	-42.80	54.30	50.55	74.00	23.45	Pass	V	PK
10	7206.0000	36.31	5.81	-42.16	46.75	46.71	74.00	27.29	Pass	V	PK
11	9608.0000	37.64	6.63	-42.10	46.77	48.94	74.00	25.06	Pass	V	PK
12	12010.0000	39.31	7.60	-41.90	45.30	50.31	74.00	23.69	Pass	V	PK

Mode:			8DPSK Transmitting					Channel:		2441	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1062.4062	27.96	2.52	-43.03	55.41	42.86	74.00	31.14	Pass	H	PK
2	2128.9129	31.88	3.62	-43.17	60.51	52.84	74.00	21.16	Pass	H	PK
3	4882.0000	34.50	4.81	-42.80	54.78	51.29	74.00	22.71	Pass	H	PK
4	7323.0000	36.42	5.85	-42.13	50.21	50.35	74.00	23.65	Pass	H	PK
5	9764.0000	37.71	6.71	-42.10	47.17	49.49	74.00	24.51	Pass	H	PK
6	12205.0000	39.42	7.67	-41.89	45.94	51.14	74.00	22.86	Pass	H	PK
7	1598.8599	29.05	3.07	-42.90	55.30	44.52	74.00	29.48	Pass	V	PK
8	2133.7134	31.89	3.63	-43.18	59.01	51.35	74.00	22.65	Pass	V	PK
9	4882.0000	34.50	4.81	-42.80	52.16	48.67	74.00	25.33	Pass	V	PK
10	7323.0000	36.42	5.85	-42.13	47.80	47.94	74.00	26.06	Pass	V	PK
11	9764.0000	37.71	6.71	-42.10	46.84	49.16	74.00	24.84	Pass	V	PK
12	12205.0000	39.42	7.67	-41.89	46.07	51.27	74.00	22.73	Pass	V	PK

Mode:			8DPSK Transmitting					Channel:		2480	
NO	Freq. [MHz]	Ant Factor [dB]	Cable loss [dB]	Pream gain [dB]	Reading [dBμV]	Level [dBμV/m]	Limit [dBμV/m]	Margin [dB]	Result	Polarity	Remark
1	1066.4066	27.97	2.53	-43.04	57.12	44.58	74.00	29.42	Pass	H	PK
2	2132.9133	31.89	3.63	-43.18	57.55	49.89	74.00	24.11	Pass	H	PK
3	4960.0000	34.50	4.82	-42.80	53.98	50.50	74.00	23.50	Pass	H	PK
4	7440.0000	36.54	5.85	-42.11	48.46	48.74	74.00	25.26	Pass	H	PK
5	9920.0000	37.77	6.79	-42.10	45.47	47.93	74.00	26.07	Pass	H	PK
6	12400.0000	39.54	7.86	-41.90	47.96	53.46	74.00	20.54	Pass	H	PK
7	1497.6498	28.40	2.99	-43.09	55.99	44.29	74.00	29.71	Pass	V	PK
8	2131.1131	31.88	3.62	-43.17	58.77	51.10	74.00	22.90	Pass	V	PK
9	4960.0000	34.50	4.82	-42.80	52.03	48.55	74.00	25.45	Pass	V	PK
10	7440.0000	36.54	5.85	-42.11	48.62	48.90	74.00	25.10	Pass	V	PK
11	9920.0000	37.77	6.79	-42.10	46.19	48.65	74.00	25.35	Pass	V	PK
12	12400.0000	39.54	7.86	-41.90	46.69	52.19	74.00	21.81	Pass	V	PK

Note:

1) Through Pre-scan Non-hopping transmitting mode and charge+transmitter mode with all kind of modulation and all kind of data type, find the DH5 of data type is the worse case of GFSK modulation type in charge + transmitter mode.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading - Correct Factor

Correct Factor = Preamplifier Factor– Antenna Factor–Cable Factor

3) Scan from 9kHz to 25GHz, the disturbance above 13GHz and below 30MHz was very low, and the above harmonics were the highest point could be found when testing, so only the above harmonics had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.